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NUEXCO

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CONTENTS

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Transmittal (ii)
The Uranium Market 1.0
Topical Essay 2.0
Raw Materials 3.0

Statistical Data

- Exchange and Transaction Values 4.0
- Transactions 4.4
- Government Statistics 4.5

Market Opportunities

- Inquiries to Borrow 5.0
- Available for Loan 5.0
- Inquiries to Purchase 5.1
- Available for Sale 5.2

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TRANSMITTAL

Readers' attention is directed to a revision in the formula for determining Transaction Value, which is described in this month's *Pricing* section.

We look forward to greeting Subscribers at the AIF Annual Conference in San Francisco, November 11-14. We will have a hospitality suite in rooms 833-4 of Hotel St. Francis, and this year's Breakfast for Subscribers and their guests will be held on Tuesday, November 13, in the hotel's California Room, West.

Nuexco broker, Jim Vaughan, expanded Nuexco's worldwide presence by planting the Nuexco flag atop Alaska's Mount McKinley, North America's highest mountain. The expedition required four weeks. The "hospitality suite" opened by Jim after arrival was closed as supplies dwindled and attendance proved disappointing.

URANIUM MARKET

Public and Government Policy

US President Carter's Commission on the Accident at Three Mile Island reported its findings and recommendations on October 30. The Commission reported that its investigation did not "require the conclusion that nuclear power is inherently too dangerous to permit it to continue and expand as a form of power generation."

The Commission was given a broad mandate to make recommendations for preventing accidents in the future, and its report included 44 specific recommendations. One is to replace the Nuclear Regulatory Commission with an executive agency headed by one person, in order to improve the efficiency of decision making, especially in times of crisis. The panel apparently considered several moratorium proposals, but none carried a majority vote. Thus it did not advise any delay or halt to nuclear power construction or operation while its safety recommendations are being considered and implemented. The Commission avoided any sweeping proposals about whether national policy should encourage or discourage commercial nuclear power, commenting that the ultimate assessment of risks vs. benefits should be left to the political process. It also did not discuss peripheral issues, such as radioactive waste disposal.

On another front, a bill has been introduced in the British Parliament apparently aimed at shielding British subjects from some provisions of US antitrust law. The bill would refuse US investigators access to British records that could help them in antitrust cases against British companies, and it would enable British subjects and companies to bring actions in British courts to recover the punitive portion (i.e. two-thirds) of any treble damage awards under the Sherman Antitrust Act.

The law would apply to all nations that bring such actions against parties in the UK, but is aimed at the US specifically. The bill was apparently prompted in part by US antitrust litigation in the uranium industry.

General: Supply and Demand Balance

Nuexco has carried out an analysis of the world supply/demand balance for natural uranium. The results of the analysis are summarized in Table 1.

Table 1
NATURAL URANIUM SUPPLY-DEMAND BALANCE: WOCA[a]
(x 1,000,000 lb U_3O_8 equivalent)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
SUPPLY[b]												
Operating Production Ctrs.	94.5	106.8	103.7	104.3	101.5	102.0	102.1	100.3	102.2	101.1	98.8	96.2
plus												
Facilities under construction	–	3.8	10.5	12.9	22.2	27.5	29.6	32.1	32.8	33.5	33.8	34.2
equals												
Firm Supply	94.5	110.6	114.2	117.2	123.7	129.5	131.7	132.4	135.0	134.6	132.6	130.4
DEMAND												
less												
Apparent Consumption[c]	76.2	77.7	97.3	102.4	120.0	112.1	121.7	122.7	127.4	128.8	132.0	127.7
equals												
Inventory Purchases	18.3	32.9	16.9	14.8	3.7	17.4	10.0	9.7	7.6	5.8	0.6	2.7
INVENTORY												
plus												
Beginning Inventory	160	178	211	228	243	247	264	274	284	291	297	298
equals												
Ending Inventory	178	211	228	243	247	264	274	284	291	297	298	300
Beginning Inventory ÷ Annual Consumption = Relative Inventory Level (yrs.)	2.1	2.3	2.2	2.2	2.0	2.2	2.2	2.2	2.2	2.3	2.3	2.3

a. World Outside Communist Areas
b. Ref. Nuexco Report No. 134
c. Ref. Nuexco Report No. 132

Before interpreting the results, however, some discussion of the methodology and fundamental assumptions is in order.

1. The critical assumption is that uranium production centers in operation or under construction as of this writing (defined as "firm supply" for purposes of this analysis) will be able to sell their projected U_3O_8 output. Much of the material defined as firm supply is already committed by contract for future deliveries. In some cases, the production facility's future output is committed to a single buyer, either through national ownership or through direct utility participation in uranium supply. It is assumed that the remainder of total projected firm supply can be sold, even if only for inventory accumulation in a time of apparent excess supply.

2. Planned production centers—those with production plans and identified ore reserves, but which have not yet begun construction—are not considered in this analysis under the definition of firm supply.

3. Nuexco production estimates for centers operating or under construction were added, and the results are tabulated in Table 1, designated "Firm Supply." The methodology for Nuexco estimates of U_3O_8 production was discussed in detail in Reports No. 133 and 134.

4. Another fundamental assumption is that annual demand would be greater than or equal to annual consumption. This has been borne out in uranium industry practice. To the extent that annual demand exceeds annual consumption, inventory is accumulated.

5. Annual consumption is determined using the Nuexco estimate of Apparent Future Consumption, a concept introduced in Report No. 128 and updated in Report No. 132. It is important to note that Apparent Future Consumption takes no account of reactors not yet ordered. Consequently, Apparent Future Consumption will understate demand by the amount attributable to orders yet to be placed, as well as by inventory purchases.

6. In order to facilitate understanding of the analysis, the methodology used for Nuexco's estimate of Apparent Future Consumption is summarized below:

   a. Estimates of Apparent Future Consumption should be regarded as a comparatively hard component of total demand, and relatively insensitive to uranium prices. Market demand for the assumed pattern of capacity additions can be higher, but is not likely to be lower.

   b. Demand can exceed Apparent Future Consumption because of accelerated reactor construction schedules or inventory purchases by utilities.

   c. Reactor loading is calculated, for each reactor, based on its individual core characteristics. It is assumed that: 1) U_3O_8 deliveries for first cores predate commercial operation by two years; 2) first reload occurs 12 months after commercial operating date, and annually thereafter; 3) U_3O_8 delivery for each reload predates reload by 18 months.

   d. Actual commercial operating dates can differ widely from published dates. Nuexco uses the best information available, much of it from unpublished sources.

   e. These estimates make no provision for orders not yet placed. Only the consumption associated with reactors operating, under construction or on order are included.

   f. Reactors fueled by the USSR are excluded.

7. Inventory refers to natural uranium inventory (U_3O_8 and UF_6) owned by utilities, reactor manufacturers, fuel fabricators and national uranium procurement organizations. The inventory amounts do not include strategic stockpiles such as that owned by US DOE. Difficulties in accounting precisely for the variety of possible forms, locations and ownership of uranium inventory necessarily result in some uncertainty in estimating the total world natural uranium inventory. The Nuexco computation of natural uranium inventory as of the beginning of 1979 is approximately 160 million pounds; however, the uncertainty factor of this estimate is ten to fifteen percent. More important is the fact that the primary conclusions of this analysis are not sensitive to beginning inventory variations of ten to fifteen percent from the estimated 160 million pounds U_3O_8 at the beginning of 1979.

Interpretations and Conclusions

1. In each year, firm supply exceeds apparent consumption, so supply and demand are balanced

URANIUM MARKET

by additions to inventory. In actual practice, if supply exceeds demand over an extended period, the necessary balance will probably result from a combination of inventory purchases and reduced production. In this analysis, however, under the assumption that producers will be able to produce and sell all firm supply, the conclusion is that there will be excess production every year from now through 1990, and that excess production will add to inventory.

2. The world inventory of 160 million pounds U_3O_8 at the beginning of 1979 is equivalent to 2.1 years' supply at the current rate of consumption. By 1990, this analysis indicates that inventory will nearly double to 298 million pounds U_3O_8, but a corresponding rise in apparent consumption will have maintained approximately the same relationship between inventory and annual consumption. Thus, in 1990, beginning inventory will be equivalent to 2.3 years' supply at the 1990 rate of consumption. For each year considered in this analysis, the ratio of beginning inventory level to annual consumption is from 2.0 to 2.3.

3. An interesting observation is that an inventory level equivalent to two years' consumption appears to be a generally accepted level of comfort among utilities. While some utilities (e.g. some US utilities) favor a minimum inventory policy, and others (e.g. Japanese utilities) favor large inventories, two years is an oft-quoted target figure. Under the ground rules of this analysis, a world industry average of two years' forward inventory appears to be feasible, even if only production centers currently operating or under construction are considered.

4. If demand is to be sufficient to support production from production centers planned, but not yet under construction, it will most likely arise either from new reactor orders or from political or policy considerations. Inventory buying heavy enough to support this third group of production centers would create a significant increase in the ratio of inventory to consumption.

Australia

Australian uranium marketing efforts have increased during the past two months. The publicity surrounding Roxby Downs and other recent uranium developments in Australia has tended to obscure the fact that the government has granted marketing approval to only three projects: Western Mining's Yeelirrie, Ranger's Jabiru and Queensland Mines' Nabarlek, with the last two having been most visible in the marketplace—the result of being closer to production.

Queensland has completed mining the Nabarlek deposit, and now has all its ore graded and stockpiled, on the surface, adjacent to the mill site. The 200 ton per day mill is scheduled for completion by March 1980, with commercial operation scheduled for mid-year. With an average feed grade of almost 2.0 percent U_3O_8, Queensland will produce about 2.5 million pounds U_3O_8 annually during the period 1981-1988. Over 50 percent of the Nabarlek production is already committed to Japanese buyers and to repay borrowings from the Australian government, leaving less than 10 million pounds available for commitment to other buyers.

The Ranger situation is markedly different, both in size and complexity. The Jabiru deposits are estimated to contain over 220 million pounds U_3O_8, with an average grade of about 0.3 percent. Announced annual output is 6.6 million pounds U_3O_8. Mine and mill development are underway. Like Queensland, Ranger has already committed some tonnage to Japanese buyers and also has commitments to repay uranium borrowed from the government, but these quantities are modest, compared with the scheduled production rate and total Jabiru reserves.

The government's decision to seek buyers for its share of the Ranger project has resulted in a number of proposals from a broad cross-section of the international uranium community. Pending resolution of this situation, any marketing of the government's share of production is in abeyance.

The list of finalists includes organizations from the United States (Esso, Phillips Petroleum, Union Carbide, Utah International and Newmont), Canada (Denison), the UK (British Civil Uranium Procurement Organization, jointly with the German firm Urangesellschaft), France (Cogema and EDF jointly), Italy (AGIP) and Australia (Mary Kathleen, Brambles Industries, Peko-Wallsend together with Japanese partners, CSR together with French and Korean interests, and Australian United Corporation, a merchant bank, on behalf of undisclosed principals).

Western Mining and its partners do not contemplate producing from Yeelirrie before 1985, as a result of their decision to evaluate different recovery processes in a pilot mill. Their reserves are estimated at over 100 million pounds U_3O_8 at a grade of 0.15 percent. Announced annual output is 5.5 million pounds U_3O_8. Based on announced arrangements among the owners, only 40 percent of Yeelirrie production remains to be marketed by Yeelirrie Development Company, a subsidiary of Western Mining Corporation, with the remainder handled by Urangesellschaft (10 percent) and Esso/Exxon (50 percent, including 35 percent to be purchased from Yeelirrie Development Co.).

Although new sales from all three projects have been rumored, such "sales" amount in reality only to agreements in principle between the parties, for it can be reliably reported that, to date, the government has yet to give final and formal approval to any new contracts.

Canada

At the Seminar on Markets for Canadian Uranium held in Calgary, Alberta, on October 25, it was observed that since 1975, over $300 million have been spent on exploration in Saskatchewan, and that exploration expenditures in 1979 would exceed $80 million. It was further observed that the Amok/SMDC Cluff Lake operation is still expected to reach full output capacity by 1982. Construction of the mill at the SMDC/Uranerz/Eldor Resources Key Lake operation is expected to begin soon. The current schedule indicates completion of the facility in 1983 and full output capacity the following year.

The public statement by the new federal Conservative government regarding the liquidation of Canada's stockpile was viewed with some alarm at the Seminar, given the recognition of an already difficult near-term export market for western Canada's uranium industry. The consensus was that the government would behave responsibly when fully apprised of existing market conditions.

Central Africa

It has been reported that a consortium headed by Japan's Overseas Uranium Resources Development Company (OURD) has discovered a rich uranium deposit in an exploration concession in the Republic of Niger. The deposit is located in the Asphalt district in the southern part of the Sahara, and is said to contain at least 30,000 metric tons of uranium (78,000,000 pounds U_3O_8) at an average depth of 400 meters. OURD commented that it is too early to determine whether the deposit is economically recoverable at today's prices.

Europe

Although the future of nuclear power in Sweden will be determined by a referendum in the spring of 1980, most of the political parties in Sweden have taken a stand on nuclear power. The five parties appear to be inclined as follows:

Conservative (73 votes in parliament): pro-nuclear
Central (64 votes): anti-nuclear
Communist (20 votes): anti-nuclear
Liberal (38 votes): supports limited use of nuclear power
Social Democratic (154 votes): previously a pro-nuclear group. TMI apparently caused a party split, with the labor union faction still pro-nuclear. The party will take a stand before the referendum.

While it is too early to predict the results of the referendum, the overall pro-nuclear stand of the new government is a positive sign.

During the first half of 1979, electricity production from nuclear power in the countries of the European Economic Community increased by 14 percent, compared to the same period in 1978. The largest increases were in France, 44 percent; FRG, 14 percent; and Belgium, 10 percent.

Switzerland's fourth nuclear power unit, the 906 MWe Goesgen reactor, completed its six-week power demonstration this month, and was formally transferred to the owner.

Southern Africa

Third quarter uranium production for South Africa's gold/uranium producers is as follows:

	Pounds U_3O_8
Blyvooruitzicht	151,000
Buffelsfontein	337,000
ERGO	145,000
Harmony	295,000
Hartebeestfontein	226,000
JMS	345,000
Randfontein	272,000
Stilfontein	168,000
Vaal Reefs	837,000
West Driefontein	165,000
Western Deep Levels	105,000
West Rand Consolidated	203,000
Total	3,251,000

URANIUM MARKET

Total production for the third quarter is 12.1 percent higher than for the previous quarter. The increase is due largely to two factors— the buildup of production from the new south plant of the Vaal Reefs complex and the early startup of the new Chemwes plant at Stilfontein. Construction of the Stilfontein facility commenced in early 1978 and was originally scheduled for completion in 1980. It is designed to process 270,000 metric tons per month of uranium-bearing tailings from old gold mining operations. This quarter 545,000 metric tons were processed, for a yield of 0.14 kg U_3O_8 per metric ton treated. By the end of the quarter, Stilfontein was operating at 80 percent of designed capacity.

The president of the South African Electricity Supply Commission (ESCOM) recently commented that South Africa expects to have 15,000 MWe of nuclear power operating by the year 2000. Electricity consumption in South Africa has been growing at an annual rate of nine percent. ESCOM's first units at the Koeberg site (two 920 MWe units supplied by Framatome) are still on schedule and are expected to be completed in 1982 and 1983, respectively.

United States

The original prohibition on the use of foreign-source uranium in US reactors associated with the Private Ownership Act of 1964 is now being phased out to the point where it is no longer of commercial significance. However, with the current slow uranium market and reduced apparent demand, the question of a new embargo on uranium of non-US origin has been raised frequently in recent months. While US producers would generally be expected to favor the protection such an embargo might offer, most industry observers have concluded that a US import embargo is most unlikely. The reasons usually cited are as follows:

1. *Political problems.* Several important US uranium producers and potential producers are also important oil companies (e.g. Exxon, Kerr-McGee, Getty, Sohio, Chevron, ARCO, Gulf, Conoco, Mobil). An import embargo which would help maintain or increase US uranium prices might be viewed as an aid to these oil companies. At present, most US politicians would rather their constituents believe they are making oil companies the "victims" of their efforts, as opposed to beneficiaries. This attitude seems to prevail regardless how irrational the results produced by such an approach might be.
2. *Lack of political clout.* About three-fourths of current uranium production in the US comes from two states, New Mexico and Wyoming. The combined population of those states is less than one percent of the total US population. Therefore, at the federal level, the political clout of the uranium-producing states is low. Further, uranium is a small business when viewed in the context of the total US economy. US production for 1979 is estimated to total about 38 million pounds U_3O_8. Even if all of this production were sold at today's Exchange Value, the annual industry volume would be only $1.6 billion. The oil industry, by comparison, is well over $100 billion. In other words, the uranium industry is not large enough in the US to be politically significant to the population as a whole.
3. *Small balance of payments effect.* US uranium consumption is expected to level off at 55 to 60 million pounds U_3O_8 per year in the mid-1980's. Present US production plus new production facilities under construction will yield about 45 million pounds U_3O_8 annually (see Report No. 133). Even if no additional US production comes on line in this period, net imports are unlikely to exceed 15 million pounds per year, or 25 percent of total US consumption. At today's prices, the net balance of payments deficit would not be expected to exceed about $600 million, or about one percent of the current US balance of payments deficit for petroleum.
4. *Embargoes are politically sensitive.* Trade restrictions are always deeply resented by trading partners, and are thus hotly debated, very sensitive matters of international relations. A US uranium import embargo would be especially resented by the biggest and nearest trading partner of the US, namely, Canada. Since the US is becoming increasingly dependent on Canada for supplies of oil and gas, it is unlikely that a selective import embargo on uranium fuel would be considered.
5. *No analogy to earlier embargo.* The earlier US import embargo was designed to assist an already established US uranium industry in making the transition from a government-dominated military procurement market to a fledgling commercial market. No analogy to that situation currently exists.

In summary, the US uranium industry is relatively small; providing import embargo protection appears to be too politically unrewarding to make it a likely prospect.

Coincident with industry concern about a US import embargo, there appears to be some concern among industry participants that the US may, at some time in the future, place an embargo on the export of uranium of US origin. Two conditions, in particular, appear to prompt that concern. First is the belief that exporting would be viewed unfavorably if the US has to import uranium to meet its domestic requirements. Second is the general uncertainty caused by US non-proliferation policies. There are several reasons, however, why it is unlikely that an export embargo will be implemented.

1. *US non-proliferation objectives.* US non-proliferation policy was founded on the assumption that granting or withholding of nuclear fuel could induce conformance of overseas governments with US objectives. On the contrary, however, the result of recent unilateral US policy action has been to increase the interest of non-US users in geographical diversification of supply. An embargo of US-origin U_3O_8 could only erode US influence further.

2. *Free trade favored.* US government policies generally favor free trade, and international negotiations usually aim to reduce trade barriers. An export embargo would be inconsistent with those aims. If the US becomes dependent on overseas uranium for part of its requirements, reliability of supply will become more important. Restricting US exports while simultaneously encouraging exports by others would be contradictory.

3. *US security of supply.* An export embargo would not appear necessary from a national security-of-supply standpoint. According to US DOE, US utilities currently hold inventories of more than twice annual US consumption. In addition, the US government's strategic stockpile represents considerably more than one year's consumption of U_3O_8. Therefore, any risk to US security of supply implicit in free trade in uranium would be mitigated by these large stockpiles, since any boycott of the US by uranium-producing nations would not disrupt US electricity production.

4. *US not a big exporter.* Table 2 sets forth the Nuexco estimate of current US export and import commitments for the period 1979-1990. In the years 1979 and 1980, exports and imports are approximately balanced. Thereafter, annual US export commitments are less than ten percent of annual US firm supply, as defined in the *General* section of this Report. While it is likely that additional export commitments will be made, it is not likely that the total will be large enough to be of true political or economic significance in the US. Consequently, there will be little political driving force to enact an export embargo on uranium.

Pricing

The **Exchange Value** remained at \$42.20/lb. U_3O_8 this month. The spot and near-term markets remain quiet, as most sellers continue to resist price cutting to effect sales. There are a few buyers in the near-term market and these have, for the most part, been

Table 2
US EXPORT-IMPORT BALANCE[a]
(x 1,000,000 lb U_3O_8 equivalent)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
IMPORTS												
Annual	6.3	4.4	6.4	6.9	5.0	4.7	2.1	3.2	4.5	4.5	4.5	4.5
Cumulative	6.3	10.7	17.10	24.0	29.0	33.7	35.8	39.0	43.5	48.0	52.5	57.0
EXPORTS												
Annual	7.3	5.1	3.4	2.6	2.7	2.7	2.2	1.6	1.5	1.5	1.1	1.0
Cumulative	7.3	12.4	15.8	18.4	21.1	23.8	26.0	27.6	29.1	30.6	31.7	32.7
NET IMPORTS (EXPORTS)												
Annual	(1.0)	(0.7)	3.0	4.3	2.3	2.0	(0.1)	1.6	3.0	3.0	3.4	3.5
Cumulative	(1.0)	(1.7)	1.3	5.6	7.9	9.9	9.8	11.4	14.4	17.4	20.8	24.3

a. Does not include contracts currently under litigation.

willing to buy only at a "discount from market."

The apparent activity is in the intermediate and long-term markets. The central point of current negotiations for this intermediate and long-term supply remains the search for pricing terms which meet the differing objectives of buyers and sellers. The two-tier floor/market mechanism which predominated in 1976-77 has undergone substantial metamorphosis, as the market has shifted away from seller dominance. The main changes include:

Discounts from market price. The rationale articulated by buyers, which is increasingly acceptable to sellers, is that there is little or no incentive to contract forward if the buyer must pay full market price. The utility argues that if it must pay full market price, it might just as well wait until its needs are close at hand. The counter-argument that security of supply and timely development of production facilities are the primary reasons for forward contracting, carries less weight in today's market where demand is slipping, current and perceived supply appears adequate and prices have been soft.

Lower floor prices. Whereas previous floor prices tended to be at or close to the then-current market levels, there is now a distinct shift toward lower floor prices and reduced escalation factors. The primary impetus behind this change has been situations where formula floor prices now exceed perceived market levels—a condition which for some buyers is, at best, embarrassing. Thus, buyers are seeking arrangements that reduce or eliminate completely the possibility of paying more than market price while, with a few exceptions, sellers insist on some mechanism which would prevent their being compelled to produce and deliver below cost.

As reported in US DOE's most recent *Survey of United States Uranium Marketing Activity* (DOE/RA 0038) and amplified at DOE's Uranium Industry Seminar in Grand Junction (October 16-17, 1979) there are some market price related contracts which guarantee delivery, but do not have floor prices. These contracts were concluded before the current period of market weakness, and it remains to be seen whether such arrangements would be acceptable to producers today.

In this connection, it should be noted that the papers presented at Grand Junction contained a great deal of market-related data. Of particular interest were the increased amount of price information collected, analyzed and presented in the market Survey discussed in George Combs' paper, and the series of price projections presented in Gene Clark's paper. When compared with previous presentations, it is apparent that, year-by-year, DOE is collecting additional market and price data, and as a consequence is increasingly prepared to comment on the commercial trends shown by these data.

The **Transaction Value** was established by Nuexco nearly two years ago as an objective measure of near-term prices. It was designed with a relatively dynamic market in mind, and it was assumed that there would usually be a large enough volume of business to keep it reasonably up to date. However, it was recognized at the time that there would be some inertia in the Transaction Value by definition, and that changes in the Transaction Value would lag changes in the Exchange Value. As part of the original computational ground rules, a present worth analysis was included to take into account the time value of money.

Recently, however, it has become apparent that the original formula for determining the Transaction Value has shortcomings in certain market conditions. Today, instead of being dynamic in the near-term, the market has been very slow. Few new transactions qualify for inclusion in the Transaction Value calculation. To further complicate matters, the Exchange Value has been slipping and interest rates, due to rapid inflation, are at an all-time high. As a result, the Transaction Value as calculated by its original definition has developed into an anomaly. This is a characteristic shared by all objectively-determined formulas for determining price; market conditions may change such that the formula no longer presents a reasonable result.

Under the definition of Transaction Value, a minimum of ten transactions and two million pounds are required in the calculation. It has often been necessary lately to go back six months to satisfy these ground rules. Present-valuing over six months introduces significant distortion, especially with very high interest rates. Also, the present value calculation yields a somewhat erratic result over time, especially if one or two large transactions remain in the sample for several months. While these effects were foreseen when the Transaction Value definition was established, their magnitude was underestimated.

For these reasons, it has been decided that the present value calculation be deleted from the Transaction Value determination. Thus, the Transaction Value will continue to show characteristic inertia, and change in it will lag change in the Exchange Value. However, erratic oscillation in Transaction Value should be removed by the deletion of the present-worth factor. The Transaction Value will now simply be a weighted average defined as follows:

> *The Transaction Value is a weighted average price of recent transactions, and is based on prices paid for U_3O_8 in transactions closed within the previous three-month period and for which delivery was scheduled within one year of the transaction date. At least ten transactions totaling at least two million pounds U_3O_8 are included in each calculation, or the sample time is extended as necessary to include these minima. Foreign currencies are converted to US dollars as of the transaction date.*

All previous Transaction Values have been recalculated on this new basis, and are tabulated on page 4.2 of this Report. In Figure A below, the Transaction Values determined by the new definition are compared to those determined by the original defintion, from January 1977 through September 1979. It is apparent that, while the market was active and interest rates modest during 1977 and the beginning of 1978, the two methods yielded comparable results. It was only after the market began slowing and interest rates began to rise rapidly that the problems with the former definition developed. It is hoped that with the revised definition, the Transaction Value will continue to provide a useful measure of price movements in the uranium market.

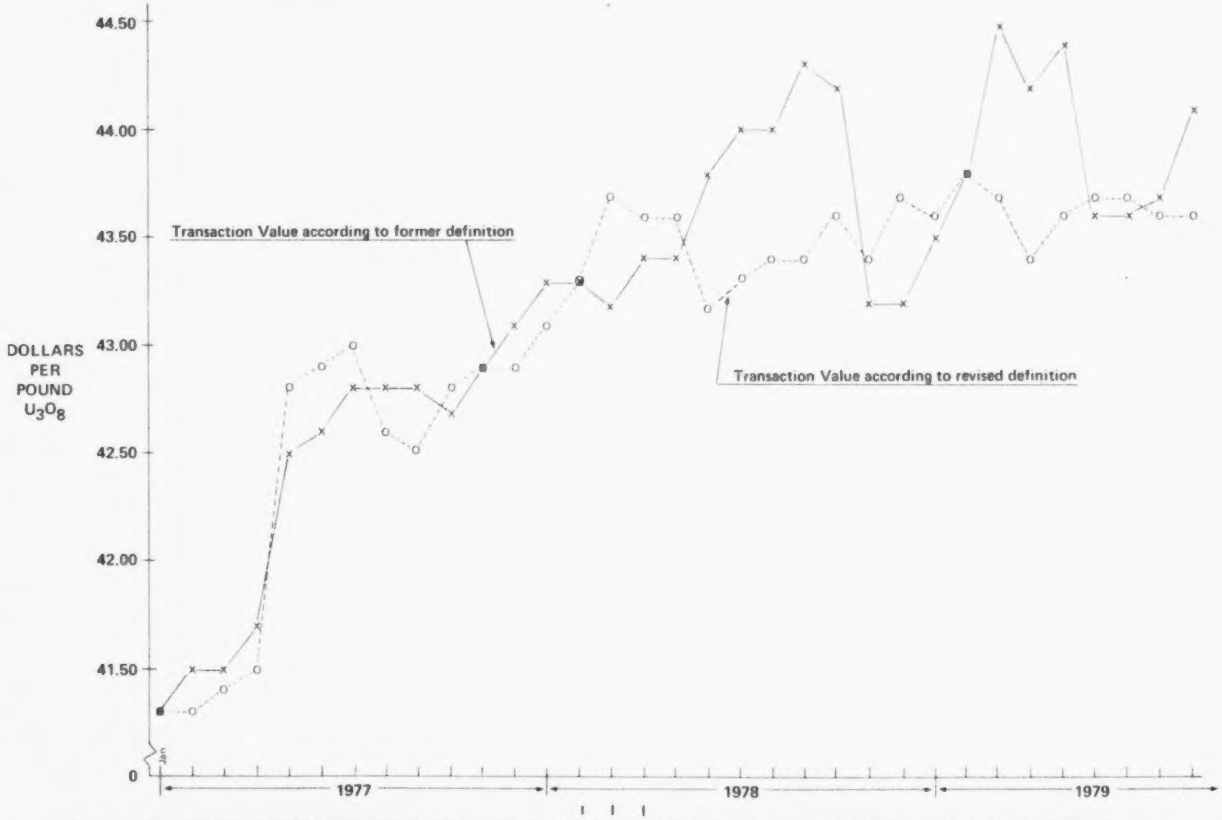


Figure A: COMPARISON OF NEW DEFINITION OF TRANSACTION VALUE WITH FORMER DEFINITION

TOPICAL ESSAY

Marketing and Procurement: Tools of the Trade - II

Last month's *Topical Essay* discussed the meaning, use and implications of bids, offers and inquiries. Brokers represent an additional tool often used in the marketing and procurement of uranium.

Who Are the Brokers?

In the broadest sense, a broker is any person or entity whose business it is to bring buyer and seller together, or to act as a negotiator between parties, and is compensated for such involvement, usually on the basis of a contingent fee. The following general classifications of brokers exist in the uranium industry:

1. *Full-time brokers:* Sole or primary business is arranging uranium-related transactions and providing services which enhance such transactions. Nuexco is an obvious example.
2. *Part-time brokers:* Primary business is related to the nuclear power industry; engage in uranium brokerage as an additional line of business.
3. *Occasional brokers:* Primary line of business may or may not be uranium related; engage in uranium brokerage on an occasional basis when opportunities arise. Do not actively seek the business, as do the *full-time* and *part-time brokers.* The occasional broker is often closely associated with one or more particular buyers or sellers as a consequence of its primary business activities.
4. *Consultants:* Primary business is built around normal retainer and *per diem* consulting arrangements, but occasionally, because of specialized knowledge, have an opportunity to become involved in a uranium transaction on a contingent fee basis. Includes fuel cycle and geological consultants.
5. *Agents:* Normally engage in long-term, longstanding relationships representing sellers of uranium.These relationships may be exclusive,or limited geographically or by customer. Agency relationships are almost always established to facilitate international marketing, with the Japanese trading companies being the most obvious example.
6. *Traders:* Buy and sell uranium for their own risk and account, earning income on the difference between the purchase price and the sale price. Some nuclear reactor vendors and fuel fabricators have been traders in uranium.
7. *Representatives:* Serve to increase geographic or market coverage for the other identified types of brokers. They are usually small, independent companies or individuals.

Role of the Broker

The introduction of a broker into a uranium transaction does not alter the nature of the basic transaction. Brokers can and do make bids and offers on behalf of the parties, and initiate various types of inquiries. However, in many instances, brokers can provide additional services and market knowledge otherwise unavailable to buyers and sellers. They can also employ various marketing and procurement techniques which often cannot be utilized by buyers and seller themselves.

While many buyers and sellers are sophisticated in market matters, it is almost axiomatic that the broker, to be successful, must be more so. For example, a buyer may have an excellent feel for the current position of sellers, but his knowledge of other buyers with whom he is competing is unlikely to be complete. The same is true for sellers who know their customers well, but do not know their competitors equally well. A good broker, by virtue of being positioned in the center of the market, should have knowledge of both sides. In addition, it is the broker's business to know the special situations outside of or beyond the regular buyer/seller relationship. Thus, utilities wishing to purchase uranium will always canvas the known producers, but might not know of or seek out exploration companies, would-be producers considering entering the market, potential foreign sellers or other utilities or manufacturers which, for some reason, may have material for sale on a one-time basis. Likewise, producers would not normally consider other producers as likely purchasers of uranium.

Specialized marketing and procurement techniques represent the second broad area in which brokers can bring flexibility and a new dimension to the regular buyer/seller relationship. The most frequently used technique is the anonymous bid, offer or inquiry, wherein buyer or seller may wish to approach the market without revealing its identity. For example, to effect a scheduled delivery, a producer may elect to purchase uranium rather than produce it. Such a decision has obvious competitive

TOPICAL ESSAY

implications, and the producer may wish to keep a purchase of this type confidential.

The services of a broker, together with a bank letter of credit, can provide a party with complete anonymity. Likewise, without revealing its identity, a buyer or seller can make a bid or offer incorporating new prices, terms, conditions or ideas, without a commitment to reveal its identity unless the bid or offer is accepted. Or, it might utilize the inquiry approach to ascertain whether such a new approach would be acceptable.

A variation on this approach available to brokers, but not to buyers and sellers themselves, is the simultaneous inquiry. In this, the broker prepares a proposal for simultaneous transmittal to buyer and seller. This is not done on a random basis, but is typically aimed at buyers and sellers whose individual requirements and production capabilities appear to be a suitable match. Obviously, this approach is feasible only when the buyer and seller have procurement and marketing philosophies which allow the construction of a proposal appealing to each. The broker must have thorough knowledge of potential clients in order to be able to make such a selection from numerous buyers and sellers.

The principal advantage of the simultaneous inquiry is that the broker, as a third party, initiates the contract, thus freeing both buyer and seller from the need to reveal identities and expose negotiating postures. This allows buyer and seller to retain maximum flexibility, since each can disclaim authorship of the proposal. Several variations of this approach are possible, i.e., buyer identified to seller, seller identified to buyer, etc.

Thus, a broker can add a dimension to the normal interface between buyer and seller. While neither a panacea nor a replacement for the procurement and marketing functions, a broker is an additional tool which most market participants have utilized at one time or another.

Compensation of Brokers

Like other business enterprises, brokers are paid for their work. Brokers are usually compensated for results, rather than effort, since they are generally paid on a contingency basis. The variables in broker compensation are source, basis and amount of payment.

With respect to source, the broker, in almost every instance, must look to either buyer or seller, lender or borrower, land-owner or developer; i.e., one of the parties to the transaction, or in some cases, both parties. The exception to this is when the broker takes the middle position, buying from one party and selling to another, earning its fee on the spread between purchase price and sale price.

Similarly, experience has shown that brokers tend to be paid by the party against whom the market is skewed. Thus, in a sellers' market (more buyers than sellers, more demand than supply, and rising prices), the buyer is more apt to pay. Conversely, in a buyers' market (more sellers than buyers, more supply than demand, and falling prices), the seller is more apt to pay. Agents associated with particular sellers are exceptions to this rule and are almost always paid by the sellers, regardless of market conditions.

In a balanced market, the determination of who pays the broker's fee is often the subject of considerable negotiation.

Regarding basis of payment, there appear to be the following options:

1. *Percentage Compensation:* Payment is a percentage of price. This approach is most apt to be utilizelized by agents who are associated with specific sellers.
2. *Flat Compensation:* Payment is unrelated to price and is an agreed-upon amount per pound U_3O_8 or, alternatively, a specific lump sum for closing a specific transaction.
3. *Risk Compensation:* Gained through taking the position, with its attendant risk, of a principal. The aim, of course, is to buy at one price and sell at a higher price. A trader usually receives its compensation in this manner, although a broker sometimes will if the purchase and sale are arranged on a back-to-back basis.

Knowing the nature and basis of the broker's financial interests enables the non-fee paying party to assess more accurately the broker's actions and advice during negotiations.

Information regarding the amount of compensation paid to brokers is generally hard to obtain. However, fees in uranium sales transactions appear to range from about 0.3 to 3.0 percent of transaction price, with agents usually on the higher end of the scale. Traders' compensation can, of course, be even higher if they buy and sell wisely, but along with the potential for greater rewards go greater risks.

RAW MATERIALS

Northeastern Washington Uranium District

Uranium prospecting has been commonplace in northeastern Washington since the early 1950's. Discovery of the Midnight deposit on the Spokane Indian Reservation in early 1954 stimulated prospecting throughout the entire eastern part of the state. However, reports of uranium discoveries were primarily limited to the northeastern sector where prospecting, exploration, mine development and milling have continued, in one form or another. To date, at least 99 uranium occurrences have been discovered in six separate areas within the district (see map); another 15 to 20 discoveries have been reported in other areas of the state.

The discovery of the Midnight ore deposit in 1954, and of the Sherwood & Daybreak deposits in 1955, was the incentive for prospectors to converge on the new district. Mineral occurrences were subsequently discovered in a variety of geologic environments from Precambrian to Tertiary Age. The areas considered to be generally favorable for uranium exploration included Tertiary basins where poorly-sorted arkosic and tuffaceous sandstones and conglomerates occur, intercalated with volcanic flows and volcaniclastic rocks; in intrusives and associated metamorphic rocks with related faulting, fracturing and shearing within older rocks; and in areas where certain metals occur in close association (most commonly, molybdenum, tungsten and copper). Extensive exploration was carried out during the following few years, but discoveries were primarily limited to occurrences which are not economically recoverable. Interest in the area began to wane and by 1959, only the three deposits listed above had been discovered. The number of prospectors in the area decreased to less than a dozen.

Project development at that time was primarily limited to mining and milling of the Midnight Mine by the newly-formed Dawn Mining Company (51 percent controlled by Newmont Mining Corporation, 49 percent by Midnight Mines, Inc.) Dawn began open-pit mining in 1956 and production of yellowcake at a newly-constructed, 440 ton per day mill at Ford, Washington, in 1957. The mine and mill operated continuously until April 1965. Mining and milling resumed at full production levels in 1970, and are still in progress today. Production from the Midnight Mine has totaled about 10.6 million pounds U_3O_8, during the 18 years it has been in operation. The average grade of the ore exceeded 0.21 percent U_3O_8 during the first 15 years; in the past three years, the grade has decreased to ±0.14 percent U_3O_8.

The Sherwood deposit was discovered by the Northwest Uranium Company in 1955. The Silver Buckle Mining Company mined 306,000 pounds U_3O_8 at an average ore grade of 0.17 percent during the period 1958-1963. Western Nuclear, Inc. (WNI), gained control of the property and adjacent acreage in 1966. Exploration resumed immediately, and by 1968, WNI had drilled out reserves which were eventually estimated to exceed 14 million pounds U_3O_8, at an average ore grade of 0.088 percent. WNI began open-pit mining on the Sherwood deposit in 1977, and completed construction of a 2000 ton per day mill in April 1978. In less than two years of operation, about 800,000 pounds U_3O_8 have been recovered by WNI.

Operations at the Daybreak Mine were initiated in late 1955. The first ore mined by Daybreak Mining Company was shipped to the Vitro mill in Salt Lake City, Utah. Later, the ore from Daybreak and six small deposits in the immediate area was processed at the Dawn mill. Total production from the area is about 100,000 pounds. Unmined reserves at the Daybreak pit and the Bear Creek shaft are estimated at about 40,000 pounds U_3O_8. WNI controlled the Daybreak property from the mid-1960's through 1976. It is now controlled by Energy Fuels Exploration Company of Denver, Colorado.

Exploration activity throughout the district was at a low level during the period 1960-1974. However, following the discovery of reserves of about 500,000 pounds U_3O_8 by WNI on the northern slope of Spokane Mountain (about a mile northeast of the Midnight Mine) in 1975, exploration activity increased significantly. By mid-1977, 25 to 30 companies were exploring, and another 20 to 25 were prospecting and/or attempting to secure land, primarily within the vicinity of Spokane Mountain. Additional interest in the district has since diminished considerably as a result of only limited exploration successes. Eight to twelve companies are presently exploring throughout the state. At this time, activity is perhaps at its highest level on the reservation and in northern and northeastern Ferry County.

Uranium mineralization in the Northeastern Washington district occurs in crystalline rocks. The Front Range of Colorado is the only other area in the

US where economically recoverable uranium deposits are known to occur in a crystalline environment; the major deposits in France, Australia and Canada are in a similar environment. Generally, such deposits have greater tonnage and are higher in U_3O_8 content. It is this common geological setting that has attracted prospectors to the Washington district.

The district, in general, and the Spokane Mountain area, in particular, consist of a Cretaceous granite of batholithic proportions, intruded into Precambrian metasediments. The intrusion created shearing, fracturing and metamorphism of the older sedimentary rocks throughout the region. Eocene Tertiary dikes intruded all of the older rock, creating further alteration. Miocene Tertiary volcanics which once covered the region are now represented as erosional remnants overlying the granite and older rock at higher elevations. The Columbia River basalt covers much of the area at the lower elevations, usually below 2500 feet. Uranium mineralization has been discovered in all of the major rock units, from Precambrian through Tertiary Age. The three important ore deposits in the Spokane Mountain area occur in this geologic environment.

The Midnight deposit was the first to be discovered. Mineralization is concentrated in graphite and muscovite schists of the Precambrian Togo formation adjacent to the contact with the Midnight pluton—a quartz monzonite intrusion often referred to as the Loon Lake granite. Stringers of mineralization extend downward into the monzonite.

Ore deposits have been discovered at depths of from 15 to more than 300 feet. Individual deposits vary in thickness from one or two feet to over 40 feet; ore widths vary to over 200 feet, and lengths may exceed 700 feet. Uranium minerals present in the deeper, unoxidized zones are coffinite and pitchblende, while uranophane and autunite are the main ore minerals in the oxidized zones.

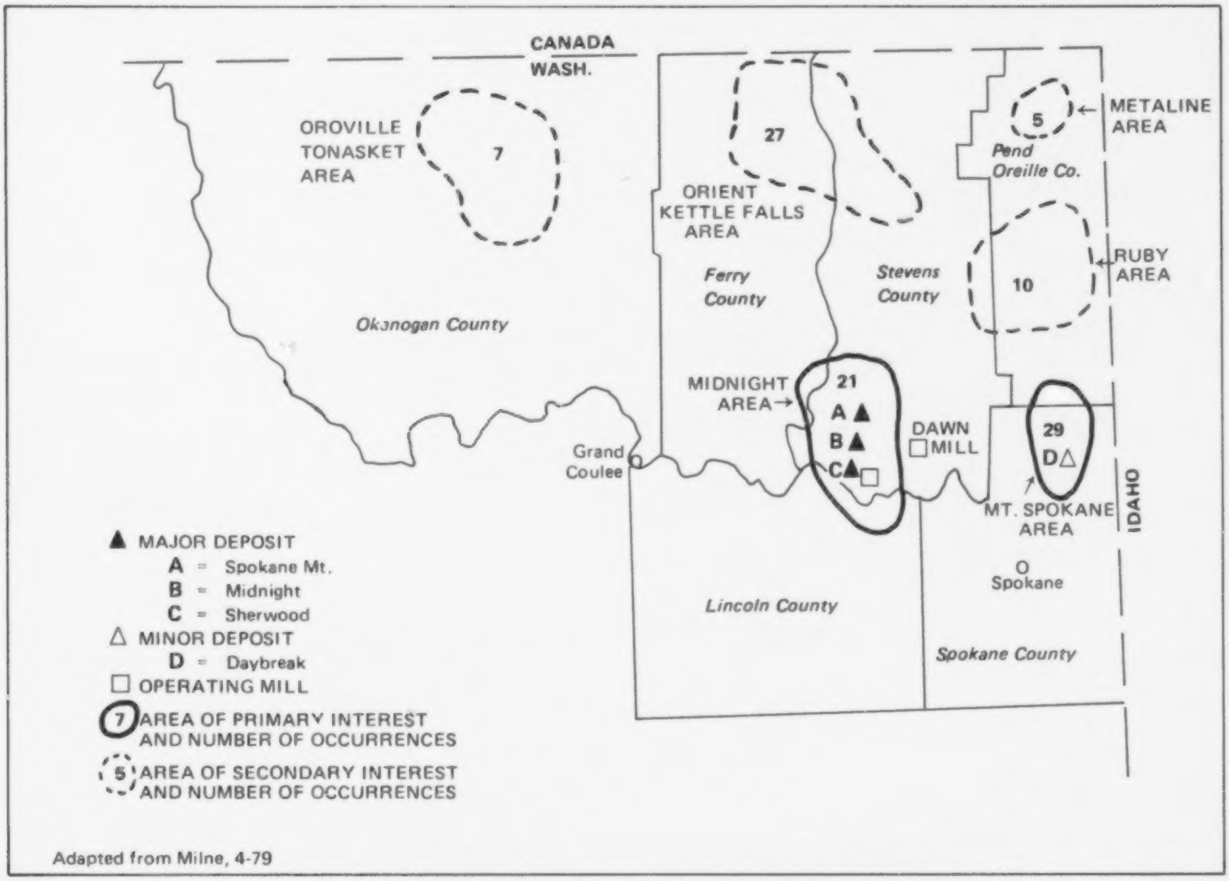
The uranium in the Togo Formation probably originated due to hydrothermal fluids moving through the uranium-rich quartz monzonite and into the metasediments, where the uranium was deposited as a precipitate. In turn, uranium in the metasediments was partially remobilized and redeposited in altered metasediments and Eocene dikes. The theory of remobilized uranium is supported by the fact that the ground water in the mine area is uranium-rich; the formation of secondary ore minerals at the water table has also been noted.

The Sherwood uranium deposit is located four miles south of the Midnight deposit on the same structural trend. The Midnight pluton (quartz monzonite) is the oldest rock in the vicinity of the deposit. Monzonite outcrops near the site of the original ore discovery, but is otherwise covered by the Tertiary Sanpoil volcanic sequence consisting of 180-600 feet of conglomerates, pyroclastic sediments, shales, tuffaceous sand units and andesite flows. The Sanpoil, in turn, is capped by 5-50 feet of the Columbia River basalt of Miocene Age. Five to ten feet of glacial debris cover much of the mine's surface area. Uranium mineralization occurs only in the lower 200 foot-thick conglomeratic member of the Sanpoil.

The ore deposit has been displaced approximately 200 feet by a high-angle normal fault which trends almost north-south. The down-dropped block is to the west, and the ore-bearing conglomerate is adjacent to quartz monzonite in the eastern fault block. The thickness of the ore zone on the western side of the fault averages 60 feet, and the host conglomerate varies from about 80 to 200 feet overall. On the eastern side of the fault, the thickness of the ore zone averages 20 feet in a conglomerate that is only 60 feet thick—the reduced thickness is considered to be due to post-faulting erosion.

The eastern portion of the orebody is almost completely oxidized. The main ore mineral has been tentatively identified as meta-autunite. The ore zone shows disequilibrium of radiometric values and chemical values, probably due to oxidation caused by a fluctuating ground water table. Uraninite and coffinite are the main ore minerals associated with the unoxidized portion of the western orebody, and disequilibrium of the ore is not known to be a problem. Nevertheless, an ore-control system has been devised to automatically compensate for any irregularities which might be encountered during exploration and mining.

Uranium mineralization occurs as a coating on sand grains, pebbles and boulders of the conglomerate. The origin of the minerals is unknown. However, with the similarity of the occurrences to the mineralization of the Midnight deposit, hydrothermal emplacement is a possibility. Another source of mineralization might have been erosion of uranium-


CANADA
WASH.
OROVILLE
TONASKET
AREA
7
27
ORIENT
KETTLE FALLS
AREA
5
METALINE
AREA
Pend
Oreille Co.
10
RUBY
AREA
Ferry
County
Stevens
County
Okanogan County
MIDNIGHT
AREA
21
A
B
C
DAWN
MILL
29
D
MT. SPOKANE
AREA
IDAHO
Grand
Coulee
Spokane
Lincoln County
Spokane County
▲ MAJOR DEPOSIT
A = Spokane Mt.
B = Midnight
C = Sherwood
△ MINOR DEPOSIT
D = Daybreak
□ OPERATING MILL
7 AREA OF PRIMARY INTEREST AND NUMBER OF OCCURRENCES
5 AREA OF SECONDARY INTEREST AND NUMBER OF OCCURRENCES

Adapted from Milne, 4-79

MAP OF NORTHEAST WASHINGTON URANIUM DISTRICT – SIX-COUNTY AREA SHOWING URANIUM AREAS OF PRIMARY AND SECONDARY INTEREST

bearing rocks from a highland area such as the Midnight area, with subsequent deposition of the uranium along faults and in the coarse sediments filling paleochannels in the quartz monzonite.

The Spokane Mountain uranium deposit was discovered by geological, geophysical and geochemical methods. It is located about one mile northeast of the Midnight area, on the same structural trend as both the Midnight and Sherwood deposits. Uranium mineralization occurs in Togo metasediments which have been folded, sheared intensely, fractured and faulted by the later intrusion of the quartz monzonite. Mineralization is associated with chloritic schist and graphitic phyllite in a deeply-weathered segment of the Togo Formation overlying the irregular surface of the monzonite. Drilling indicates that the orebody has been offset by several high-angle faults which more or less parallel the main structural trend.

The principal ore minerals in the altered segment of the Togo are meta-autunite and uranophane, both oxidized minerals. Pitchblende occurs as a reduced mineral and is probably the most important ore mineral present. Emplacement of the mineralization may have occurred under circumstances similar to the Midnight deposits. Even so, remobilization of uranium minerals could be more important to this particular deposit due to the intense weathering of the host rock, and to the association of the intruded Tertiary dikes which may, in turn, have been an additional source of mineralization.

Uranium activities in the Mt. Spokane area (northeastern Spokane Country) have had little economic impact on the district, but the nature of the uranium occurrence is important to future exploration. The Daybreak deposit is the largest of at least 29 discoveries made in the area. Mineralization at the Daybreak mine occurs along a major shear zone in Tertiary alaskite, the predominant host rock in the Mt. Spokane Area. Pegmatite dikes are common to the area and have contributed to the shearing, fracturing, faulting and alteration of the alaskite.

The only uranium mineral present is meta-autunite. Unoxidized minerals have not been noted in the area. Thus, the source of uranium probably was the uranium-rich alaskite. The uranium was remobilized during a period of intense rock alteration and precipitated out of the ground water in the favorable structural and altered environment.

It appears that additional "easy to find" ore deposits (Midnight, Sherwood and Daybreak) may not exist except, possibly, at greater depths. If so, a more sophisticated approach to exploration will be required to locate ore deposits. WNI has already proved this with the discovery of the Spokane Mountain deposit. Through the application of detailed geological interpretation, followed by at least five separate geophysical studies and two geochemical programs, and eventually a comprehensive drilling program, the deposit was discovered at depths of 150 to 500 feet. Such an approach may be the key to successful exploration programs in the future. Project costs will be considerably higher, but so will the chances for success.

In summary, important uranium exploration successes in the Northeastern Washington district have been limited primarily to the area around the Midnight deposit located on the Spokane Indian Reservation in Stevens County. The favorable geologic environment of that particular area exists in much of the northeastern sector of the state. To date, at least 99 uranium occurrences have been reported in areas where uranium-rich plutons and adjacent metasediments, volcanic flows and intrusive dikes occur in association with prominent structural features. Regardless of the apparent potential that exists for the district, exploration activity is at the lowest level in almost three years.

STATISTICAL DATA

EXCHANGE VALUE — $42.20/lb U_3O_8

Change from one month ago: $0.00/lb U_3O_8 (0.0%)

Change from one year ago: –$0.80/lb U_3O_8 (–1.9%)

DEFINITION

The Exchange Value is Nuexco's judgment of the price at which transactions for significant quantities of natural uranium concentrates could be concluded as of the last day of the month.

DERIVATION

Nuexco bases the Exchange Value upon:

A. Data from recently completed transactions.
B. Data from pending transactions.
C. Firm bids to buy and firm offers to sell.
D. Prices purchasers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy, and prices sellers have expressed a willingness to accept, but for which Nuexco is not aware of firm offers to sell.

COMMENTS

Nuexco does not consider the following in determining the Exchange Value:

A. The price of uranium delivered or to be delivered under old contracts.
B. The price of uranium delivered in connection with contract renegotiations or other than arm's length transactions.

TRANSACTION VALUE — [redacted]/lb U_3O_8

Date	U.S. $/lb U_3O_8	Millions of lbs	Number of Transactions	Number of Months
This Month	43.60	2.5	15	6
Last Month	43.60	2.5	15	5
One Year Ago	43.60	2.7	11	5

DEFINITION

The Transaction Value is a weighted average price of recent transactions, and is based on prices paid for U_3O_8 in transactions closed within the previous three-month period and for which delivery was scheduled within one year of the transaction date. At least ten transactions totaling at least two million pounds U_3O_8 are included in each calculation, or the sample time is extended as necessary to include these minima. Foreign currencies are converted to US dollars as of the transaction date.

STATISTICAL DATA

Figure 1
HISTORICAL EXCHANGE VALUES

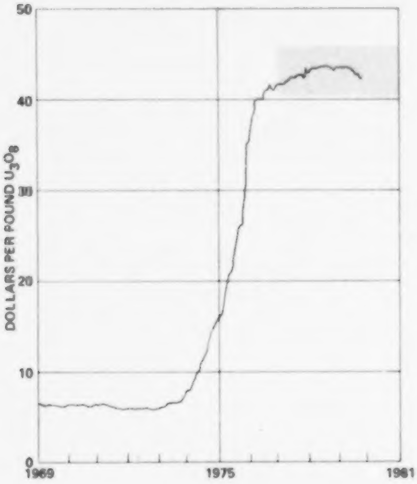


Figure 2
HISTORICAL TRANSACTION VALUES

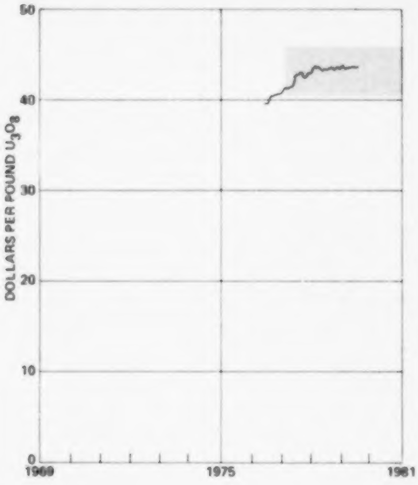
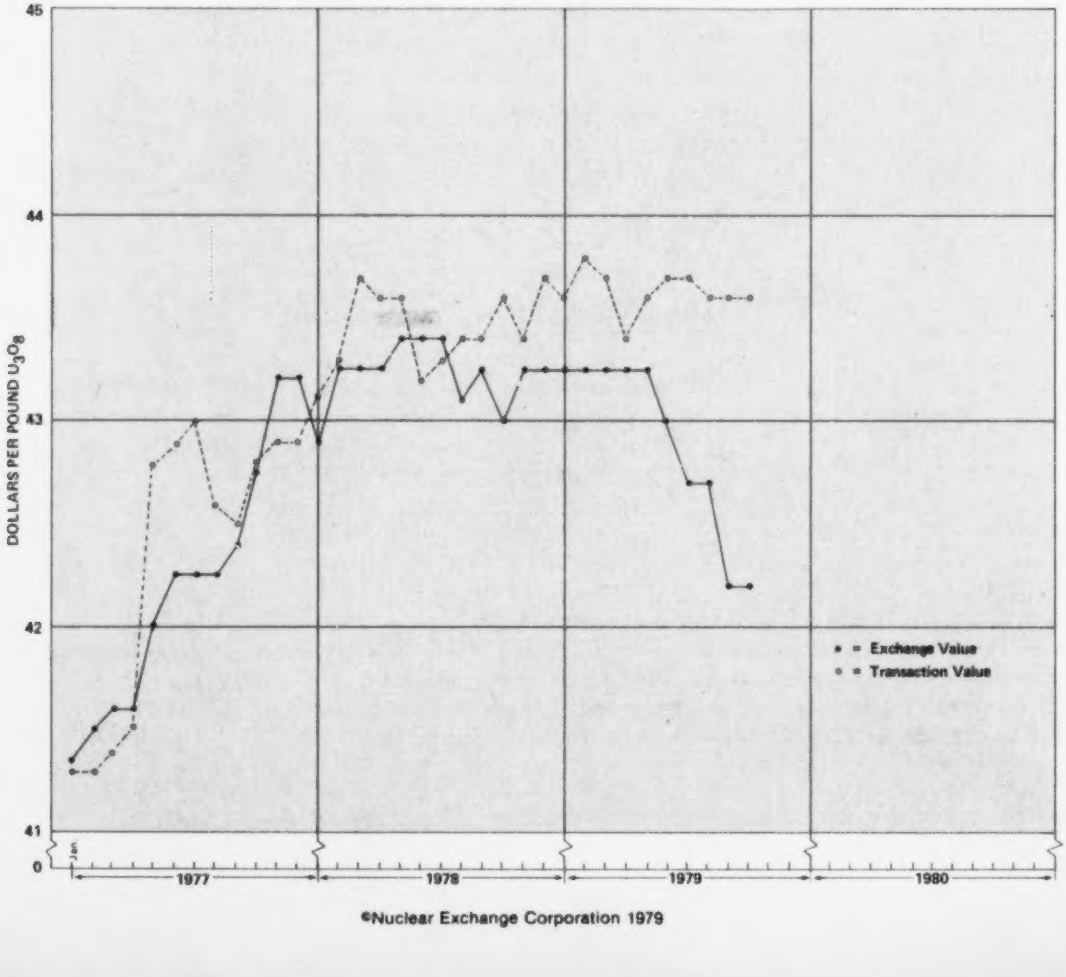


Figure 3
RECENT EXCHANGE AND TRANSACTION VALUES



STATISTICAL DATA

EXCHANGE VALUE
US Dollars/lb U_3O_8

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1968	–	–	–	–	–	–	–	6.35	6.35	6.40	6.45	6.50
1969	–	6.35	6.10	6.10	6.25	6.25	6.20	6.20	6.15	6.15	6.15	6.20
1970	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.20	6.15	6.15	6.15	6.15
1971	6.20	6.20	6.20	6.20	6.15	6.05	6.00	5.95	5.95	5.95	5.95	5.95
1972	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95
1973	5.95	6.00	6.10	6.20	6.45	6.50	6.50	6.50	6.50	6.50	6.75	7.00
1974	7.70	7.90	8.00	9.00	9.50	10.50	11.50	12.00	12.50	14.00	14.75	15.00
1975	16.00	16.00	18.00	20.00	21.00	23.00	24.70	26.00	26.00	28.50	30.00	35.00
1976	35.20	37.00	39.25	40.00	40.00	40.00	40.00	40.40	41.00	41.00	41.50	41.00
1977	41.35	41.50	41.60	41.60	42.00	42.25	42.25	42.25	42.40	42.75	43.20	43.20
1978	42.90	43.25	43.25	43.25	43.40	43.40	43.40	43.10	43.25	43.00	43.25	43.25
1979	43.25	43.25	43.25	43.25	43.25	43.00	42.70	42.70	42.20	42.20		

TRANSACTION VALUE
US Dollars/lb U_3O_8

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1976	–	–	–	–	39.60	39.70	39.70	40.40	40.30	40.60	40.70	40.70
1977	41.30	41.30	41.40	41.50	42.80	42.90	43.00	42.60	42.50	42.80	42.90	42.90
1978	43.10	43.30	43.70	43.60	43.60	43.20	43.30	43.40	43.40	43.60	43.40	43.70
1979	43.60	43.80	43.70	43.40	43.60	43.70	43.70	43.60	43.60	43.60		

Note: See earlier Nuexco Reports for evolution of the definition of Exchange Value.

STATISTICAL DATA

EXCHANGE VALUE EXPRESSED IN PRODUCER & CONSUMER CURRENCIES

Country	per lb U_3O_8 in Concentrates	per kg U_3O_8 in Concentrates	per kg U in Concentrates
US (dollar)	42.20	93.03	109.71
France (franc)	178.51	393.55	464.09
FRG (mark)	76.24	168.08	198.21
Japan (yen)	10,072	22,204	26,184
Switzerland (franc)	70.62	155.68	183.59
UK (pound)	20.48	45.15	53.24
Australia (dollar)	38.26	84.35	99.47
Canada (dollar)	49.88	109.96	129.67
Niger, Gabon (CFA)	8,926	19,677	23,204
South Africa (rand)	34.92	76.98	90.78

USE CHARGE

Loan Commencement Date	Annual Use Charge Rate %
Within next 6 months	7

USE CHARGE — Nuexco's judgment of the annual interest rate which a borrower would have to pay to obtain a near-term uranium loan. It is based upon transaction data, the money-market prime rate and the relationship among uranium inventory, supply and demand.

STATISTICAL DATA

CURRENT TRANSACTIONS*

Ref		Material & Approximate Quantity	Approx. Price as % of Current E.V.	Seller Group	Buyer Group	Remarks
951	79	Less than 50,000 lbs U_3O_8		US	US	
952	81-83	300,000 to 600,000 lbs U_3O_8	100%	US	Europe	
981	late 80's	1,000,000 to 2,000,000 lbs U_3O_8		Canada	Pacific Basin	
982	84-90	2,000,000 to 4,000,000 lbs U_3O_8		US	Pacific Basin	

* Transactions listed include not only those in which Nuexco was involved, but also all others of which Nuexco is aware.

MARKET OPPORTUNITIES

Market Opportunities are *active* inquiries in the uranium market to buy, sell, borrow or lend. The data presented in this section are in no way intended to be indicative of the entire uranium market for the time period covered.

SUPPLY

URANIUM AVAILABLE FOR SALE

Delivery Year	Pounds U_3O_8 (1000's)	Nuexco Reference Number	Remarks
1979	100	1292	
	170	1314	
1980	1000	1103	
	300	1274	
	350	1284	
1981	120	1128	
	150	1122	
	300	1274	
	250	1286	
	1000	1103	
1982	150	1122	
	120	1128	
	250	1286	

URANIUM AVAILABLE FOR LOAN

Delivery Year	Return Year	Pounds U_3O_8 (1000's)	Nuexco Reference Number	Remarks
1979	1981	650	1175	UF_6
	1983	1000	1008	UF_6
	1983	1000	1196	
	1981	1000	1136	UF_6
	1982	1000	1239	UF_6

MARKET OPPORTUNITIES

DEMAND

INQUIRIES TO PURCHASE URANIUM

Delivery Year	Pounds U_3O_8 (1000's)	Nuexco Reference Number	Remarks
1980	300	1146	
	325	1227	
	200	1207	
	700	1268	
	100	1300	
1981	250	1089	
	300	1146	
	500	1228	
	325	1227	
	200	1207	
1982	250	1089	
	300	1146	
	325	1227	
	200	1207	
	500	1228	

INQUIRIES TO BORROW URANIUM

Delivery Year	Return Year	Pounds U_3O_8 (1000's)	Nuexco Reference Number	Remarks
1979	1982	500	1121	Tentative
	1984	1000	1220	
	1983	1000	1240	Tentative
	1985	400	1287	

NUEXCO
NUCLEAR EXCHANGE CORPORATION

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EXECUTIVE SUMMARY & INDUSTRY OVERVIEW
NUEXCO REPORT NO. 135
Prepared Especially for Upper and Middle Management

US President Carter's Commission on the Accident at Three Mile Island reported its findings at the end of this month. The Commission made numerous specific recommendations for preventing accidents in the future and advised replacement of the Nuclear Regulatory Commission with an executive agency headed by one person. The Commission neither found nuclear power generation inherently dangerous enough to discontinue or halt the expansion thereof, nor did it recommend any sort of temporary moratorium while its findings are being reviewed.

The *General* section analyzes the world supply/demand balance of natural uranium.

An international consortium headed by a Japanese organization has discovered a rich uranium deposit in the Asphalt district of Niger, with estimated reserves of at least 78,000,000 pounds U_3O_8.

The virtual embargo imposed by the US on the importation of foreign uranium for use in US reactors (associated with the Private Ownership Act of 1964) is being phased out to the point where it is no longer of commercial significance. Although today's slow market and reduced apparent demand have raised the question of whether a new import embargo could be imposed, most industry observers conclude that this is highly unlikely.

This month's *Topical Essay* continues the series on uranium marketing and procurement with a discussion of brokers.

This Executive Summary may be reproduced for internal distribution.

10/31/79

NUEXCO

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NUEXCO

MONTHLY REPORT TO THE NUCLEAR INDUSTRY

NO. 136

NOVEMBER 30, 1979

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NUEXCO

MONTHLY REPORT TO THE NUCLEAR INDUSTRY

No. 136 November 30, 1979

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TRANSMITTAL	ii
THE URANIUM MARKET	1.0
GENERAL	
US Supply and Demand	1.0
AUSTRALIA	1.3
CANADA	1.4
UNITED STATES	1.4
PRICING	1.4
LOAN USE CHARGE RATE	1.5
TOPICAL ESSAY	
SPOT AND OTHER MARKETS	2.0
RAW MATERIALS	
BY-PRODUCT URANIUM FROM PHOSPHATE —PART I	3.0
STATISTICAL DATA	4.0
EXCHANGE AND TRANSACTION VALUES	4.0
LOAN USE CHARGE RATE	4.3
CURRENT TRANSACTIONS	4.4
GOVERNMENT STATISTICS	4.5
MARKET OPPORTUNITIES	5.0
SUPPLY	
Uranium Available for Sale	5.0
Uranium Available for Loan	5.0
DEMAND	
Inquiries to Purchase Uranium	5.1
Inquiries to Borrow Uranium	5.1

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TRANSMITTAL

It was a great pleasure to see so many Subscribers and other friends in San Francisco at the AIF Annual meeting. The Nuexco breakfast was attended by more than 160 people and was highlighted by the presence of a special guest—Charlie Steen, discoverer of the first primary uranium ore deposit in the US. His discovery, made in 1952 in the Northern Colorado Plateau district, marked the real beginning of the development of the US uranium industry. The discovery refuted the prevailing belief that only small, low-grade orebodies of secondary mineralization would be found in the US. Mr. Steen's discovery, later known as the Mi Vida mine, set off a surge of prospecting by amateurs and professionals alike. Additional primary orebodies have since been discovered in different geologic environments throughout the western US, but the Steen discovery was the cornerstone of the largest and most successful uranium industry in the world—a tribute to tenacious individualism.

It is also with pleasure that we announce the election of Jerry Reaves as a Vice President of the Corporation. Jerry has been with Nuexco since 1976, and most recently held the position of Manager of Business Development.

We would also like to announce the addition of a new Associate to our Menlo Park staff. W. Scott Hickman has worked part-time for Nuexco since June 1978, and will join us full time in December upon receiving his B.S. in industrial engineering from Stanford University. Scott will assist the senior staff on market studies, consulting reports, uranium transactions and the Monthly Report.

URANIUM MARKET

GENERAL

US Supply and Demand

In last month's Report, No. 135, an analysis of world supply and demand was published which showed that Apparent Future Consumption as defined by Nuexco could be satisfied, on a world-wide basis, through 1990 with uranium production centers currently in operation or under construction. Moreover, a world-wide inventory ratio of about two years' forward consumption could be continued through 1990 with only those production centers in operation or under construction. Since a two-year forward inventory is an oft-quoted level of comfort, it might be concluded that new production centers would be developed only for political or policy reasons, to accommodate reactors not yet committed to be built, or to replace existing production centers that might, for some reason, close down prematurely.

The same methodology used last month on the world-wide market has now been applied to the US market only, with the results summarized below. In treating the US alone, the potential market can be identified not only for imports, but also for potential US production centers not yet under construction.

In Table 1, Nuexco's estimates of uranium output from operating US centers plus facilities under construction are tabulated through 1990, and are designated "firm production." Also tabulated is Nuexco's annual estimate of Apparent Future Consumption for the US. After adjusting for existing export-import commitments, an annual supply surplus or deficit is determined. If the annual result is a supply surplus, it is assumed to have been added to buyer inventories. If the annual result is a supply deficit, it is assumed to have been removed from buyer inventories. The resulting beginning and ending inventory levels are also tabulated in Table 1 for each year, along with the relative inventory level for that year, in years of forward consumption.

Under the assumptions of Table 1, buyer inventories will continue to grow through the end of 1982, and will fall off thereafter. The relative inventory

Table 1
NATURAL URANIUM SUPPLY-DEMAND BALANCE: US
(x 1,000,000 lb U_3O_8 equivalent)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
PRODUCTION[a]												
Operating Production Centers	38.0	41.6	40.7	38.9	36.9	35.8	35.1	34.0	33.1	32.2	31.3	30.5
plus												
Facilities Under Construction	-0-	1.4	2.6	3.5	5.6	7.0	7.0	7.0	6.9	6.8	6.7	6.6
equals												
Firm Production	38.0	43.0	43.3	42.4	42.5	42.8	42.1	41.0	40.0	39.0	38.0	37.1
less												
APPARENT FUTURE CONSUMPTION[b]	28.6	31.6	38.6	40.0	50.5	46.0	52.6	55.3	54.4	56.3	58.6	55.2
plus												
IMPORT-EXPORT COMMITMENTS (Annual Net)[c]	–1.0	–0.7	3.0	4.3	2.3	2.0	–0.1	1.6	3.0	3.0	3.4	3.5
equals												
SUPPLY SURPLUS/(DEFICIT)	8.4	10.7	7.7	6.7	(5.7)	(1.2)	(10.6)	(12.7)	(11.4)	(14.3)	(17.2)	(14.6)
INVENTORY												
plus												
Beginning Inventory	66.4[d]	74.8	85.5	93.2	99.9	94.2	93.0	82.4	69.7	58.3	44.0	26.8
equals												
Ending Inventory	74.8	85.5	93.2	99.9	94.2	93.0	82.4	69.7	58.3	44.0	26.8	12.2
Beginning Inventory ÷ Apparent Future Consumption = Relative Inventory Level (yrs.)	2.3	2.4	2.2	2.3	2.0	2.0	1.8	1.5	1.3	1.0	0.8	0.5

a. Ref. Nuexco Report No. 134
b. Ref. Nuexco Report No. 132
c. Ref. Nuexco Report No. 135
d. George F. Combs, Jr.: "The U.S. Uranium Market – 1978-1979" USDOE; Grand Junction, Colorado; October, 1979.

level will remain at two years or above through 1984, and will consistently drop thereafter. This is an indication of the market available for imports and for new US production. Table 2 has been included as an aid to quantifying this potential market for imports and new production. In Table 2, it is assumed that US buyers will, as a whole, wish to maintain two years' forward inventory. That is, it is assumed that each year's beginning inventory will be at least equal to twice that year's consumption. To accomplish this, an "unfilled demand" would need to be filled as follows (millions of pounds U_3O_8):

	1983	1984	1985	1986	1987	1988	1989	1990
Annual	6.8	0	16.0	18.1	9.6	18.1	21.8	7.8
Cumulative	6.8	6.8	22.8	40.9	50.5	68.6	90.4	98.2

Thus, a continuation of current US buyer inventory policies could lead to a cumulative market for additional imports and new US production of about 100 million pounds U_3O_8 through 1990. However, if buyers decide to reduce general inventory levels, this market could be substantially reduced. For example, if buyers were satisfied with a minimum of an 18-month forward inventory, the cumulative market for additional imports and new US production would be reduced to about 70 million pounds (see Table 3). Indeed, if buyers were to elect to liquidate inventories completely, Table 1 indicates there would be no market for additional imports and new US production through 1990. However, experience has shown that such a policy shift is extremely unlikely.

The following circumstances will tend to increase the market for additional imports and new US production above the levels determined in the forementioned examples:

1. More export commitments will be made. This is not expected to be a major influence, but any new commitments to export uranium will increase the "unfilled demand" estimated above.
2. Shifting economics may result in the premature closing of some US production listed above as "firm production." Although this analysis has accounted for estimated depletion of reserves (cf. first line of Table 1, output from operating US production centers decreases from 41.6 million pounds in 1980 to 30.5 million pounds in 1990), it is possible, perhaps even likely, that some operating production centers in the US will shut down prematurely due to unfavorable economics. The real price of uranium has been decreasing for about two years, and some US producers are expecting a cost squeeze which may make cutbacks necessary in economically marginal facilities. Since US production costs are generally higher than those of other uranium-producing

Table 2
NATURAL URANIUM SUPPLY-DEMAND BALANCE: US
(Assumes US Buyers Maintain At Least 2 Years' Requirements in Inventory)
(x 1,000,000 lb U_3O_8 equivalent)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
APPARENT FUTURE CONSUMPTION x 2[a]	57.2	63.2	77.2	80.0	101.0	92.0	105.2	110.6	108.8	112.6	117.2	110.4
less												
BEGINNING INVENTORY	66.4[b]	74.8	85.5	93.2	99.9	101.0	99.8	105.2	110.6	108.8	112.6	117.2
– Annual Supply Surplus/	8.4	10.7	7.7	6.7								
+ Annual Supply Deficit[c]					5.7	1.2	10.6	12.7	11.4	14.3	17.2	14.6
equals												
UNFILLED DEMAND[d]	-0-	-0-	-0-	-0-	6.8	-0-	16.0	18.1	9.6	18.1	21.8	7.8
ENDING INVENTORY[e]	74.8	85.5	93.2	99.9	101.0	99.8	105.2	110.6	108.8	112.6	117.2	110.4
Beginning Inventory ÷ Apparent Future Consumption[a] = Relative Inventory Level (yrs.)	2.3	2.4	2.2	2.3	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0

a. Ref. Nuexco Report No. 132.
b. George F. Combs, Jr.: "The U.S. Uranium Market – 1978-1979" USDOE; Grand Junction, Colorado; October, 1979.
c. Ref. Table 1.
d. Unfilled Demand is defined as that additional amount of uranium, if any, which US buyers would have to purchase over and above US firm production in order to maintain a certain minimum Relative Inventory Level (Two years in Table 2, Eighteen months in Table 3).
e. Under the assumptions of Table 2, Ending Inventory is derived as the greater of Beginning Inventory +/– Annual Supply Excess/Deficit and Apparent Future Consumption (Annual) x 2.

Table 3
NATURAL URANIUM SUPPLY-DEMAND BALANCE: US

(Assumes US Buyers Maintain At Least 18 Months' Requirements in Inventory)
(x 1,000,000 lb U_3O_8 equivalent)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
APPARENT FUTURE CONSUMPTION x 1.5[a]	42.9	47.4	57.9	60.0	75.8	69.0	78.9	83.0	81.6	84.5	87.9	82.8
less												
BEGINNING INVENTORY	66.4[b]	74.8	85.5	93.2	99.9	94.2	93.0	82.4	83.0	81.6	84.5	87.9
– Annual Supply Surplus/	8.4	10.7	7.7	6.7								
+ Annual Supply Deficit[c]	——	——	——	——	5.7	1.2	10.6	12.7	11.4	14.3	17.2	14.6
equals												
UNFILLED DEMAND[d]	-0-	-0-	-0-	-0-	-0-	-0-	-0-	13.3	10.0	17.2	20.6	9.5
ENDING INVENTORY[e]	74.8	85.5	93.2	99.9	94.2	93.0	82.4	83.0	81.6	84.5	87.9	82.8
Beginning Inventory ÷ Apparent Future Consumption[a] = Relative Inventory Level (yrs.)	2.3	2.4	2.2	2.3	2.0	2.0	1.8	1.5	1.5	1.5	1.5	1.5

a. Ref. Nuexco Report No. 132.

b. George F. Combs, Jr.: "The U.S. Uranium Market – 1978-1979" USDOE; Grand Junction, Colorado; October, 1979.

c. Ref. Table 1.

d. Unfilled Demand is defined as that additional amount of uranium, if any, which US buyers would have to purchase over and above US firm production in order to maintain a certain minimum Relative Inventory Level (Two years in Table 2, Eighteen months in Table 3).

e. Under the assumptions of Table 3, Ending Inventory is derived as the greater of Beginning Inventory +/– Annual Supply Surplus/Deficit and Apparent Future Consumption (Annual) x 1.5.

nations, a prolonged buyers' market may tend to shift production out of the US.

3. New reactors may be ordered. However, due to long construction lead times in the US, new reactors are not expected to add significantly to demand until beyond 1990.

The remainder of this section is a detailed description of the methodology and assumptions used to produce the data in Tables 1, 2 and 3.

1. A critical assumption is that uranium production centers in operation or under construction as of this writing will be able to sell their projected U_3O_8 output. Much of the material defined as "firm production" is already committed by contract for future deliveries. In some cases, the production facility's future output is committed to a single buyer, through direct utility participation in uranium supply, or otherwise. It is assumed that the remainder of total projected output can be sold, even if only for inventory accumulation in a time of apparent excess supply.

2. Table 2 assumes that buyers will seek to maintain a collective inventory level equivalent to **at least two years'** requirements. This assumption has two critical implications:

a. When, after taking into account exports, imports and annual consumption, annual US production is enough, or more than enough, to maintain inventory equivalent to two years' requirements, any excess production will be added to buyers' inventories.

b. When, after taking into account exports, imports and annual consumption, annual US production is insufficient to maintain inventory equivalent to two years' requirements, US buyers will acquire the additional uranium through some combination of increased imports and purchases of new US production not yet under construction.

3. Table 3 assumes that US buyers will seek to maintain a collective inventory level equivalent to **at least 18 months'** requirements. Its implications correspond to those of the two-year assumption for Table 2.

4. Planned production centers—those with production plans and identified ore reserves, but which have not yet begun construction—are not included in this analysis. Only production estimates for production centers operating or under construction were included in the "firm production" component. The methodology for Nuexco estimates of U_3O_8 production was discussed in detail in Reports No. 133 and 134.

5. It is assumed that annual demand will be greater than or equal to annual consumption. This

URANIUM MARKET

has been borne out in uranium industry practice. To the extent that annual demand exceeds annual consumption, inventory is accumulated.

6. Inventory refers to natural uranium inventory (U_3O_8 and UF_6) held by utilities, reactor manufacturers and fuel fabricators; it does not include material held by US DOE. Difficulties in accounting precisely for the variety of possible forms, locations and ownership of uranium inventory necessarily result in some uncertainty in estimating the total US natural uranium inventory, but that uncertainty is minimized by the annual compilation and publication by US DOE of US inventory levels. Nuexco believes the US DOE estimate to be accurate to within ten percent. More important is the fact that the primary conclusions of this analysis are not sensitive to beginning inventory variations of up to 15 percent from the estimate of 66.4 million pounds U_3O_8 equivalent at the beginning of 1979.

7. Exports and imports refer to commitments in force as of this writing. Contracts under litigation are excluded.

8. Annual consumption is determined using the Nuexco estimate of Apparent Future Consumption, a concept introduced in Report No. 128 and updated in Report No. 132. It is important to note that Apparent Future Consumption takes no account of reactors not yet ordered. Consequently, Apparent Future Consumption will understate demand by the amount attributable to orders yet to be placed, as well as by inventory purchases.

9. The methodology used for Nuexco's estimate of Apparent Future Consumption is summarized below:

a. Estimates of Apparent Future Consumption should be regarded as a comparatively hard component of total demand, and relatively insentitive to uranium prices. Market demand for the assumed pattern of capacity additions can be higher, but is not likely to be lower.

b. Demand can exceed Apparent Future Consumption because of accelerated reactor construction schedules or inventory purchases by utilities.

c. Reactor loading is calculated for each reactor, based on its individual core characteristics. It is assumed that: 1) U_3O_8 deliveries for first cores predate commercial operation by two years; 2) first reload occurs 12 months after commercial operating date and annually thereafter; 3) U_3O_8 delivery for each reload predates reload by 18 months.

d. Actual commercial operating dates can differ widely from published dates. Nuexco uses the best information available, much of it from unpublished sources.

e. These estimates make no provision for orders not yet placed. Only the consumption associated with reactors operating, under construction or on order is included.

AUSTRALIA

This month's news was dominated by the announcement of the sales by the Ranger partners, Peko-Wallsend and Electrolytic-Zinc, to Korea Electric Company. The transaction involves 5,000,000 lbs. U_3O_8 for delivery over the ten-year period 1983-1992. Pricing is reported to be the higher of a negotiated market price and a partially escalated floor price. Significantly, this is the first new contract endorsed by the Australian government since 1972, and its importance to Australia and current Australian marketing efforts was underscored by the government's positive statement accompanying the sellers' press releases.

In addition to this transaction, at least three others involving Australian sellers and utility buyers have been agreed to in principle, although finalizing contract language and formal government approvals may take some time.

After a slow and uncertain start, Australian marketing efforts have accelerated. One unique feature has been the increasing degree of government involvement and interest. Mr. Anthony, Deputy Prime Minister and Minister of Trade and Resources, has been particularly prominent in the public promotion of Australian uranium. In addition, the Australian foreign service has been mobilized; several US utilities report visits by Australian trade commissioners whose aim is to assess interest and describe Australian goals and policies. This aggressive and coordinated effort reflects Australia's determination to gain a position in the world uranium market. The overall marketing strategy appears to emphasize large reserves, high grade, the opportunity to diversify sources of supply and Australia's record of reliability in supply of raw materials.

However, it should be noted that, based on available evidence, prices, terms and conditions are not being sacrificed in pursuit of this goal. Non-negotiable contract items are reported to include non-proliferation provisions, Australian delivery point, minimum and market-related prices and an insistence that buyers, with stated notice periods, accept up to 35 percent of scheduled deliveries after 1990 as natural or enriched UF_6, if conversion and enrichment capacity is available.

CANADA

Several transactions involving Canadian producers closed this month. One near-term transaction is reported at higher than Exchange Value, and two near-term sales to Pacific Basin buyers were concluded at prices related to market at the time of delivery. In addition, two large, well-publicized sales were announced this month involving the output of the Blizzard claims in British Columbia; the buyer in both cases was Korea Electric Company. The Blizzard partners involved in these sales (Norcen Energy Resources Ltd, Lacana Mining Corporation, E&B Explorations Ltd, and Geomex Resources Limited Partnership), expect production to begin in 1983. They estimate the property to contain reserves in excess of 10 million pounds U_3O_8. Development of the property is subject to approval of the provincial government.

UNITED STATES

Two transactions involving US sellers closed this month; one a small spot sale, the other a large intermediate-term transaction with a non-US buyer at a price related to market price at the time of delivery.

The US market for spot and near-term deliveries can currently be characterized as one in which the supply is very large relative to the demand. Totals of active inquiries to purchase or sell, listed in the *Market Opportunities* section of this Report (pp. 5.0 and 5.1), are as follows:

	Thousands of Pounds U_3O_8	
Year	**Available for Sale**	**Inquiries to Purchase**
1979	1,800	500
1980	1,650	1,250
Totals	3,450	1,750

While the supply is not overwhelming in an absolute sense, the following points are significant:

1. All 1.8 million pounds U_3O_8 available for sale in 1979 are "in the can" and ready for spot transfer.
2. Much of the material available for sale in 1979 is being offered by utilities seeking to reduce inventories.
3. It is presently seen as very likely that additional spot material will be actively offered within the next several months, perhaps in significant quantities.
4. Of the demand that does exist, a substantial portion is discretionary, primarily for additions to inventory.

All of the above factors would be expected to put downward pressure on prices, especially the presence of utility sellers in the market, since their reason for selling may be largely related to cash flow, and they thus might be willing to cut price in order to attract buyers.

Despite the generally bearish condition of the market, some observers point to at least three factors which may develop to somewhat mitigate the downward trend:

1. Some buyers are counting on receiving deliveries which might not be made, as a result either of disputes or technical problems. Litigation, which has developed in recent months in at least one case involving a large quantity of material, has prompted some concern. Also, some new facilities have experienced technical and regulatory problems.
2. A few producers may choose to cut back on production by closing or derating facilities which are now economically marginal. This will remove some material from competition in the near-term market.
3. If the market becomes extremely weak, and prices fall significantly, some utilities seeking to liquidate inventories may withdraw from the market if they find it difficult to justify selling at a loss.

PRICING

The **Exchange Value** decreased \$1.20 this month to \$41.00 per pound U_3O_8, resuming, after one month's respite, the decline that began in July of this year. Over the past six months, this decrease amounts to \$2.25, or about 5 percent. If allowances for inflation are included, the real dollar decrease is about 10 percent.

The continuing price decline is attributable to a number of factors which have been present in the market for some time, and have been discussed in previous Reports. Demand has been decreased and stretched out in time as a consequence of the DOE's new enrichment contract. Demand has been further eroded by cancellations of planned nuclear facilities, stretch-outs of construction schedules, unexpected outages and delays in start-ups resulting from the Three Mile Island accident and other safety and licensing reasons, and planned outages associated with steam generator repairs and other upgrading.

While demand has ebbed, current and perceived future supply have continued to expand. Buyers view the forward supply situation as adequate and, as a consequence, there is little driving force to continue to build inventory as a hedge against future unavailability.

To these generally bearish conditions must be added two others. First, the market has lost much of the support provided by non-US buyers during 1978 and early 1979, as many of them complete their inventory building programs.

Second is the emergence of an increasing amount of US utility inventory in the spot market. While the potential has existed for some time, it is only now being realized. An important motive behind the decision of some utilities to sell from inventory might be the high cost of carrying uranium inventories at a time when interest rates are at record highs. Another related reason for inventory liquidation might be that it provides an alternate means of raising cash in a very tight credit market.

While conventional wisdom suggests that buyers are always pleased to see lower prices, there is reason to believe that at least some buyers have mixed emotions about the weakening price picture. The situation is of immediate concern to those utilities which seek to dispose of excess inventory. Also concerned are those utilities which may be taking deliveries under contracts with pricing mechanisms which produce prices in excess of the generally-perceived market price at the time of delivery.

A longer-term concern involves the reaction of the potential new producers to a weakening market. This is particularly true in the United States, with its high-cost, low-grade production. Many observers feel that recent market developments could lead to extended delays in the development of new production facilities.

The **Transaction Value** declined slightly this month to $43.50. While several transactions are reported, most have pricing provisions related to market price at the time of delivery. The calculation for the current Transaction Value has been extended over seven months in order to include a minimum of ten transactions and two million pounds. Thus, the weighted average is still dominated by transactions which closed several months ago, prior to the current period of decline in the Exchange Value. Inertia in the Transaction Value is expected, and is typical of any characteristic averaged over time.

LOAN USE CHARGE RATE

One uranium loan transaction closed this month, involving a large quantity of UF_6 for immediate delivery, with the repayment period extending through the mid-1980's. The interest rate in this transaction was slightly higher than the Nuexco Loan Use Charge Rate. However, the flexible payback provisions were seen by the borrower to compensate for the higher rate.

There are several additional inquiries in the market to borrow uranium at rates at or near the current Nuexco Loan Use Charge Rate of seven percent. Some Subscribers have inquired why the Loan Use Charge Rate for uranium has remained at seven percent, while the prime money market rate in the US is currently more than fifteen percent. The reason most often given by participants in the uranium loan market is that supply and demand for uranium loans are usually independent of supply and demand in the money market. Also, the money market is affected by inflation in a way that the uranium loan market is not. Interest rates in the money market are often thought to be the sum of the "real interest rate", risk and anticipated inflation. Anticipated inflation is included because in times of inflation, money returned will have a lower real value than money borrowed. Thus, the current high rates in the money market are seen to be caused by high anticipated inflation rates. In the case of a uranium loan, the uranium returned to the lender will have the same intrinsic fuel value as had the uranium borrowed.

Thus, the variable of anticipated inflation is removed, and the uranium loan use charge rate reduces to the sum of the real interest rate and risk. Under conditions of risk viewed as reasonable by most uranium lenders, uranium is currently available for loan in large quantities for several years, at rates less than half the current prime rate. Since concerns about the availability of replacement material have diminished, many observers expect activity in the loan market to increase.

TOPICAL ESSAY

SPOT AND OTHER MARKETS

This is the third essay in a series on various facets of the uranium market.

Although there is no general agreement on their meaning, the terms *spot market, spot sale, spot purchase* and *spot price* are frequently used in the uranium industry. To attempt to define "spot" precisely is inviting debate, but, based on Nuexco's experience and discussions with a broad cross-section of the industry, it seems that spot transactions have certain common characteristics.

1. The uranium to be bought (or sold) is "in the can." That is, the material is in existence at contract signing and can be immediately identified with the contract. It might be in the form of U_3O_8 or UF_6, but, in either event, is ready for delivery, not still in the ground or in the form of unmilled ore. Physical location is not particularly important. The material could be at a mill or converter, at an enrichment facility or in transit.
2. Delivery and payment normally occur at, or shortly following, closing (contract signature).
3. Contracting is less complex than for transactions involving material yet to be produced. Simplified contracts are used, since there are fewer extenuating circumstances to address. In fact, closing is often expedited by using purchase orders, Telex exchanges or telecopied letter agreements in lieu of formal contracts.
4. Price is nearly always fixed, as delivery and payment take place at, or shortly after, closing.

Of these characteristics, the first, the existence of the uranium "in the can," appears to be the key in determining whether a transaction is a spot transaction. The subsequent characteristics stem from the first.

It can be argued that a contract with an established producer to purchase a specified quantity of U_3O_8 at a fixed price with delivery guaranteed on some specified future date, should also be viewed as a spot transaction. However, such an argument only raises the question of when a delivery ceases to be spot and becomes something else. Having uranium in the can appears to be a less arbitrary criterion than a cut-off date.

A spot price is the price paid in a spot transaction.

Near Term, Intermediate Term, and Long Term

These phrases are also used without an industry concensus regarding definition. To some, "term" refers to the length of time over which deliveries take place. To others, "term" refers to the period of time between contract execution and the conclusion of deliveries. The latter appears more useful, particularly where viewed in conjunction with such related items as specificity of delivery dates, quantities, elements of risk and pricing terms.

"Near term" through "long term" represents a time continuum and any breakdown may be viewed as arbitrary, but again, experience suggests the following:

1. *Near term.* Deliveries (excluding spot transactions) are concluded within 12 months of contract execution.
2. *Intermediate term.* Deliveries extend more than 12 months after date of contract execution but are concluded within five years of contract execution.
3. *Long term.* Deliveries extend more than five years beyond the date of contract execution.

As deliveries extend further into the future, other aspects of uranium contracts also change.

1. Contracts themselves typically become longer and more complex. There are more unknowns and "what ifs" to be addressed.
2. Delivery dates typically become less precise. Quantities to be delivered tend to become associated with months, calendar quarters or even years, rather than specific dates.
3. Quantities may also be less precise. Buyers or sellers may have the right to alter quantities within specified limits and/or after giving specified advance notice. If the seller is a new market entrant and/or deliveries are to be made from a new production facility, there may be reluctance to guarantee delivery of specific quantities due to licensing, production or technological uncertainties. In such cases, quantities may be expressed as a percentage of mine/mill output and may be subject to minimum and maximum limits. Arrangements under which the the producer is obligated to deliver only what he produces (or some percentage thereof), but which do not obligate production or deliveries of specific quantities, are known as output contracts.
4. Finally, there is price. As one moves from spot to near term to long term, pricing mechanisms tend to proliferate. Fixed prices give way to escalated base prices or cost plus arrangements. Market price features are likely to appear as the contract term

lengthens. Provisions for renegotiation also become more frequent, as buyers and sellers predictably attempt to deal with an uncertain future.

BY-PRODUCT URANIUM FROM PHOSPHATE — PART I

Introduction

Minable concentrations of phosphate occur in a variety of deposits, primarily in three different environments—igneous apatites, marine phosphorites and guano deposits. Uranium is present as a trace element in all phosphate occurrences. However, of these, marine phosphorites are of the greatest economic importance due to a higher phosphate content, larger quantities, and the relative ease in recovering uranium as a by-product. At this time, uranium recovery from apatites and guano is not economically feasible.

The world's phosphate resources are enormous. They are divided into two categories: identified reserves based upon known and tested mineral deposits; and hypothetical resources, based upon geologically predictable deposits.

Table 1 shows an estimate of phosphate resources in all geologic environments, plus estimated uranium content for each category.

Phosphate/Uranium Mineralization

Phosphate rock contains almost three percent fluorine and trace amounts of vanadium, as well as uranium. Uranium partially substitutes for calcium in apatite and crandallite, both calcium phosphate minerals. Thus, the uranium is considered to be syngenetic. Primary phosphate deposits contain low phosphate and uranium values. Higher-grade deposits are formed as a result of weathering and reworking of primary phosphate rocks and pebbles in a marine environment. The uranium content of a deposit increases in proportion to phosphate content. Secondary uranium minerals of tyuyamunite and torbernite have been identified in highly-weathered deposits; carnotite and autunite mineralization are common in fossil bones and teeth found in marine deposits.

Intensive alteration of phosphates by groundwater action and weathering produces aluminum phosphate minerals. Much of the apatite and part of the silicate are replaced to form wavellite, an aluminum phosphate, and crandallite, a calcium aluminum phosphate. The amount of phosphate varies from about six to ten percent in these deposits; uranium is enriched up to 0.012 percent U_3O_8 and is associated primarily with crandallite. The uranium content increases in proportion to calcium content. This type of mineralization is common to the Bone Valley area of Florida, where it overlies richer apatite deposits. Combined, these deposits represent a potentially valuable resource of phosphate, uranium and aluminum.

Types of Deposits

Primary igneous apatite deposits occur as intrusive masses, veins or pegmatites. Among these, the largest are the intrusive masses, usually associated with alkalic granite high in apatite. The apatite mineral is fluorapatite. Its content ranges from five to eight percent in veins and pegmatites. The size of a high-grade apatite deposit varies from a few hundred tonnes to hundreds of millions of tonnes. The uranium content of these deposits varies from 0.001 to 0.010 percent—below the current level for economical recovery.

The largest minable apatite deposits are located on the Kola Peninsula in the USSR. Other large deposits are located in South Africa, Uganda and

Table 1
WORLDWIDE PHOSPHATE RESOURCES & URANIUM CONTENT[1]

Type of Deposit	Identified Reserves[2]	Hypothetical Resources[2]	Percent Uranium
Marine	76×10^9	90×10^9	0.005 to 0.030
Igneous Apatite	3×10^9	10×10^9	0.001 to 0.010
Guano	184×10^6		0.001 to 0.003

[1] Adapted from "Uranium in Phosphate Rock," J.B. Cathcart, USGS Professional Paper 988-A, 1978.

[2] Tonnes of phosphate rock containing at least 20% P_2O_5.

Brazil. About 21 percent of the world's phosphate production came from igneous apatite deposits in 1978, approximately 85 percent of which was produced from deposits on the Kola Peninsula.

Guano deposits are formed primarily from the excreta of sea birds. Phosphate-rich deposits are formed as the soluble phosphate in guano is dissolved by surface and ground water and carried downward to react with and alter the underlying rock. If the rock is limestone, apatite mineralization is formed; if it is of igneous origin, aluminum phosphates are formed. Deposits measuring many millions of tonnes have developed over extensive periods of time. About five percent of the world's phosphate production is from guano deposits.

Marine phosphorite deposits are known to exist in formations of all geologic ages from Precambrian to Pliocene (Tertiary). The thickest, richest deposits have formed in regional basins or synclines, associated with structural highs, locally referred to as platforms. Generally, these deposits show blanket deposition consisting of evenly-bedded and/or cross-bedded detrital phosphate sands and gravels, intermixed with phosphatic shales, sands and limestones. Phosphatized bone and shale fragments are common, and often contain greater amounts of phosphate and uranium. The P_2O_5 content of the deposits averages about 30 percent. In some cases, course-grained phosphate sediments occupy channels cut into the older rock, forming deposits containing an average of about 40 percent P_2O_5.

Most of the world's marine phosphorite deposits are located within the latitudes 40°N and 40°S. The deposits formed in warm, tropical ocean currents along an eastern coast of each continent. The phosphatic material was reworked by warm submarine currents and/or subjected to weathering, forming deposits which are potentially economically recoverable. The most important deposits of this type are located in the southeastern US and in the Mediterranean area along the northern limits of Africa.

Secondary deposits of uraniferous phosphorite are common, but much smaller than marine deposits. Extensive weathering of phosphate rock has created residual deposits. Apatite is more resistant to weathering than rock constituents such as carbonates; thus, calcite is weathered away from phosphatic limestone, resulting in higher-grade phosphate and uranium mineralization. The uranium content in these deposits will have an approximate range of 0.001 to 0.017 percent U_3O_8. The phosphate content may be comparatively high, although the deposits are usually small and only of local importance.

Certain Tertiary lake beds in Wyoming, Nevada and Utah contain thin, fine-grained, uraniferous phosphorite beds. The phosphate content varies from about 5 to 11 percent, the uranium content from 0.05 to 0.12 percent. Higher values of each mineral have been reported as isolated occurrences. Deposits in this environment are small and have only limited economic potential for uranium.

Phosphate and Uranium Resources

Marine phosphorite resources are considered to be either identified reserves—deposits evaluated for grade and tonnage, and considered to be economically recoverable using available technology—or hypothetical resources—undiscovered deposits in geologically favorable districts. World phosphorite resources are outlined in Table 2. Average uranium content and estimated uranium resources are also listed. The uranium content in identified reserves has been so uniform that the same values have been assigned to hypothetical resources. The estimate for total tonnes U_3O_8 includes all resources.

Production

World production of phosphate rock totaled 116 million tonnes in 1978, of which about 75 percent, or 87 million tonnes, was from marine deposits. By-product uranium is potentially recoverable from all marine phosphorites. However, no process has been developed to selectively extract uranium from phosphate rock. The method currently used in preparing for uranium recovery is acidulation, the complete digestion of the rock with sulfuric acid, and is commonly referred to as the "wet-process" for producing phosporic acid. Thus, the availability of uranium is currently limited to the application of wet-process technology. Of the total uranium present in the phosphate resources listed in Table 2, approximately one-half is recoverable using current technology.[1]

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[1] Phosphoric acid is also made from elemental phosphorus. Uranium cannot be recovered from this. About eight percent of all phosphoric acid produced is from elemental phosphorus.

Table 2
URANIUM RESOURCES IN MARINE PHOSPHORITES[1]

Resource Location	Phosphates		Estimated Uranium Content	
	Identified Reserves[2]	Hypothetical Resources[2]	Percent	Total Tonnes
United States	20×10^9	15×10^9	0.009	3,150,000
Africa	45×10^9	50×10^9	0.009	8,500,000
Mid-East & Asia	10×10^9	10×10^9	0.008	1,600,000
Latin America	5×10^9	5×10^9	0.008	800,000
Australia	5×10^9	10×10^9	0.006	780,000
Pacific Islands	0.2×10^9	0.1×10^9	0.005	15,000

[1] Adapted from "Uranium in Phosphate Rock," J.B. Cathcart, USGS Professional Paper 988-A, 1978.

[2] Tonnes of phosphate rock containing at least 20% P_2O_5.

Acidulation of phosphate rock is an intermediate step in the production of phosphoric acid. Uranium contained in the rock remains in the acid stream, from which 90 percent is potentially recoverable. Producers closely guard details of their respective recovery techniques, but solvent extraction is the basic process utilized to strip uranium from phosphoric acid. Actually, the recovery process is essentially the same as that developed on behalf of the US Atomic Energy Commission in the early and mid-1950's, with slight modifications developed through independent research and development studies by phosphate and/or uranium producers in the early 1970's.

Production capacity of wet-process phosphoric acid is presently about 27 million tonnes per year in the non-Communist world. US production was 9.75 million tonnes P_2O_5 in 1978. World wet-process acid production could potentially yield approximately 12,250 tonnes U_3O_8 annually. The US portion of production could yield about 4,400 tonnes of that total.[2]

The uranium recoverable through the acidulation process is dependent upon a number of conditions. First, recovery technology must be available—at least six US companies have recovery technology; three are recovering uranium, and three are preparing to do so within the next year; several foreign producers are interested, and plans have been announced for one production facility. Second, the economics of recovery must be favorable—demonstrated by the actions of the six US producers, all of whom have structured their recovery operations on a selling price of approximately US $40.00 per pound U_3O_8. Third, demand for uranium concentrate must be sufficient—evidenced by the fact that the above-mentioned companies pre-sold at least a portion of future production prior to initiating recovery plant construction.

Additional requirements relating to those already listed include: separating uranium recovery costs from phosphoric acid production costs—unofficially estimated to range from $28.00 to $35.00 per pound U_3O_8; phosphoric acid plant capacity—an annual capacity of 120,000 to 150,000 tonnes P_2O_5 is considered the minimum production level required to support an economical uranium operation; the uranium content of the incoming acid—a concentration of 120 to 150 mg/l is considered to be feasible for recovery; the acid to be processed should be free, or easily made free, of inorganic and organic contaminates to obviate additional processing; location of the uranium plant—the transfer of uranium-rich phosphoric acid to and from the uranium plant must be convenient for handling large volumes, possibly from more than one acid plant; and open-pit mining of large tonnages is required.

The phosphate deposits in the southeastern US are among the largest in the world, and are presently the most important to international markets. The deposits in Florida are, in turn, the most important in the US phosphate industry. Potentially minable phosphorite reserves for the district are approximately 12.0 billion tonnes, of which about 4.0 billion tonnes, economically minable by current methods, are located in Florida. In 1978, approximately 5.3 million tonnes P_2O_5 were produced in Florida, of which about 4.3 million tonnes originated in the central and southern parts of the state. Based upon an estimated average uranium content of 0.015 percent for the 4.3 million tonnes, the phosphoric acid contained approximately 1,950 tonnes U_3O_8.

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[2] One tonne P_2O_5 contains one pound U_3O_8—an average for central and southern Florida only.

The central and southern deposits of Florida offer the greatest economic potential for the recovery of uranium from phosphoric acid operations relative to favorable mining conditions and higher uranium content (0.015% U_3O_8/tonne compared to an average of 0.008% for the rest of the district). These deposits have been estimated at 1.8 billion tonnes of minable phosphate, containing about 204,115 tonnes U_3O_8. As stated before, complete recovery of uranium is not currently feasible. Not all producers of phosphoric acid will opt to recover the uranium contained in their product.

Part II of this article will be included in Nuexco Report No. 137. It will contain a description of by-product uranium recovery operations and other phosphate activities throughout the rest of the world.

STATISTICAL DATA

EXCHANGE VALUE — $41.00/lb U_3O_8

DEFINITION

The Exchange Value is Nuexco's judgment of the price at which transactions for significant quantities of natural uranium concentrates could be concluded as of the last day of the month.

DERIVATION

Nuexco bases the Exchange Value upon:

A. Data from recently completed transactions.
B. Data from pending transactions.
C. Firm bids to buy and firm offers to sell.
D. Prices purchasers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy, and prices sellers have expressed a willingness to accept, but for which Nuexco is not aware of firm offers to sell.

COMMENTS

Nuexco does not consider the following in determining the Exchange Value:

A. The price of uranium delivered or to be delivered under old contracts.
B. The price of uranium delivered in connection with contract renegotiations or other than arm's length transactions.

TRANSACTION VALUE

Date	$/lb U_3O_8	Millions of Pounds	Number of Transactions	Number of Months
This Month	43.50	2.7	17	7
Last Month	43.60	2.5	15	6
One Year Ago	43.40	2.1	13	4

DEFINITION

The Transaction Value is a weighted average price of recent transactions, and is based on prices paid for U_3O_8 in transactions closed within the previous three-month period and for which delivery was scheduled within one year of the transaction date. At least ten transactions totaling at least two million pounds U_3O_8 are included in each calculation, or the sample time is extended as necessary to include these minima. Foreign currencies are converted to US dollars as of the transaction date.

STATISTICAL DATA

Figure 1
HISTORICAL EXCHANGE VALUES

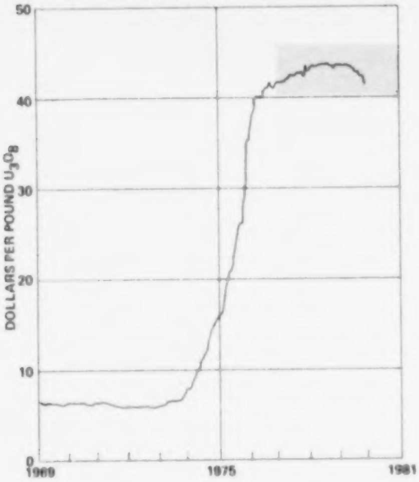


Figure 2
HISTORICAL TRANSACTION VALUES

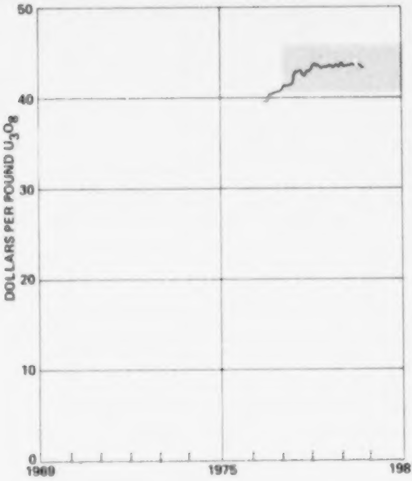
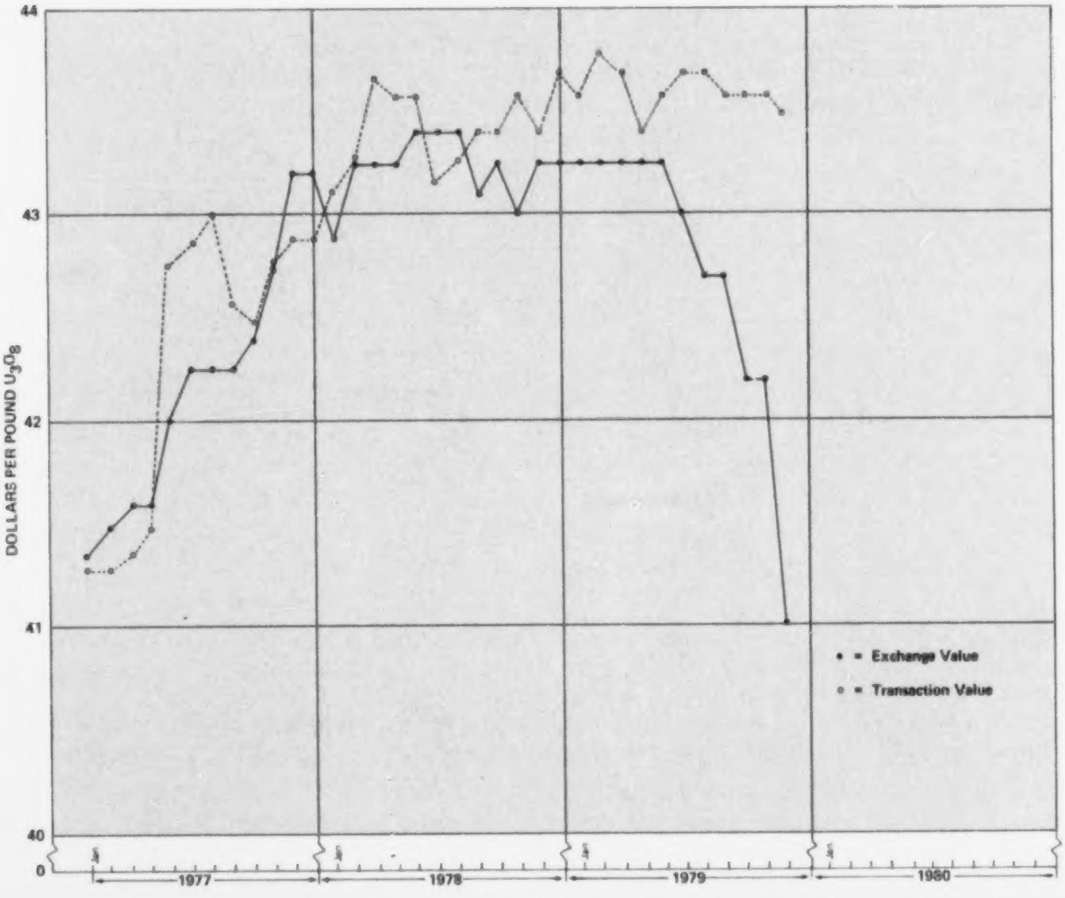


Figure 3
RECENT EXCHANGE AND TRANSACTION VALUES



STATISTICAL DATA

EXCHANGE VALUE
US Dollars/lb U_3O_8

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1968	–	–	–	–	–	–	–	6.35	6.35	6.40	6.45	6.50
1969	–	6.35	6.10	6.10	6.25	6.25	6.20	6.20	6.15	6.15	6.15	6.20
1970	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.20	6.15	6.15	6.15	6.15
1971	6.20	6.20	6.20	6.20	6.15	6.05	6.00	5.95	5.95	5.95	5.95	5.95
1972	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95
1973	5.95	6.00	6.10	6.20	6.45	6.50	6.50	6.50	6.50	6.50	6.75	7.00
1974	7.70	7.90	8.00	9.00	9.50	10.50	11.50	12.00	12.50	14.00	14.75	15.00
1975	16.00	16.00	18.00	20.00	21.00	23.00	24.70	26.00	26.00	28.50	30.00	35.00
1976	35.20	37.00	39.25	40.00	40.00	40.00	40.00	40.40	41.00	41.00	41.50	41.00
1977	41.35	41.50	41.60	41.60	42.00	42.25	42.25	42.25	42.40	42.75	43.20	43.20
1978	42.90	43.25	43.25	43.25	43.40	43.40	43.40	43.10	43.25	43.00	43.25	43.25
1979	43.25	43.25	43.25	43.25	43.25	43.00	42.70	42.70	42.20	42.20	41.00	

Note: See earlier Nuexco Reports for evolution of the definition of Exchange Value.

TRANSACTION VALUE
US Dollars/lb U_3O_8

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1976	–	–	–	–	39.60	39.70	39.70	40.40	40.30	40.60	40.70	40.70
1977	41.30	41.30	41.40	41.50	42.80	42.90	43.00	42.60	42.50	42.80	42.90	42.90
1978	43.10	43.30	43.70	43.60	43.60	43.20	43.30	43.40	43.40	43.60	43.40	43.70
1979	43.60	43.80	43.70	43.40	43.60	43.70	43.70	43.60	43.60	43.60	43.50	

STATISTICAL DATA

EXCHANGE VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES*

Country	per lb U_3O_8 in Concentrates	per kg U_3O_8 in Concentrates	per kg U in Concentrates
US (dollar)	41.00	90.39	106.59
France (franc)	166.33	366.69	432.42
FRG (mark)	70.78	156.03	184.00
Japan (yen)	10,224	22,541	26,581
Switzerland (franc)	65.07	143.45	169.16
UK (pound)	18.67	41.15	48.53
Australia (dollar)	37.46	82.59	97.39
Canada (dollar)	47.98	105.78	124.74
Niger, Gabon (CFA)	8,316	18,335	21,621
South Africa (rand)	34.05	75.07	88.53

*Currency exchange rates as of the last business day of the month.

LOAN USE CHARGE RATE — 7.0%/year

DEFINITION

The Loan Use Charge Rate is Nuexco's judgment of the annual interest rate at which uranium loans could be concluded as of the last day of the month.

DERIVATION

Nuexco bases the Loan Use Charge Rate upon:

A. Data from recently completed or pending loan transactions.
B. Rates included in firm proposals to borrow or lend.
C. Rates that potential borrowers and lenders have expressed a willingness to pay or accept, but for which Nuexco is not aware of firm proposals.

STATISTICAL DATA

CURRENT TRANSACTIONS*

Ref	Delivery Period	Material & Approximate Quantity	Approximate Price as % of Current E.V.	Seller Group	Buyer Group	Remarks
991	81-83	1,000,000 to 2,000,000 lbs U_3O_8	–	US	Pacific Basin	Price is market-related
993	79-81	300,000 to 600,000 lbs U_3O_8	–	Africa	Europe	Price is market-related
994	80	100,000 to 300,000 lbs U_3O_8	–	Canada	Pacific Basin	Price is market-related
998	79	Less than 50,000 lbs U_3O_8	100	US	US	
1000	83-92	4,000,000 to 7,000,000 lbs U_3O_8	–	Australia	Pacific Basin	Price is market-related
1001	83-93	2,000,000 to 4,000,000 lbs U_3O_8	–	Canada	Pacific Basin	Price is market-related
1006	79	1,000,000 to 2,000,000 lbs U_3O_8	–	US	US	Loan
1007	83-93	4,000,000 to 7,000,000 lbs U_3O_8	–	Canada	Pacific Basin	Price is market-related
1008	79-80	100,00 to 300,000 lbs U_3O_8	104	Canada	Canada	

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* Transactions listed include not only those in which Nuexco was involved, but also all others of which Nuexco is aware.

STATISTICAL DATA

US GOVERNMENT STATISTICS

	Producer Price Index—Industrial Commodities (1967 = 100)(1)	Gross Average Hourly Earnings of Production or Non-Supervisory Workers(2)		
		Metal Mining (SIC 10)	**Primary Non-ferrous Metals (SIC 333)(3)**	**Chemicals and Allied Products (SIC 28)**
Annual Avg. 1970(4)	110.0	3.88		3.69
Annual Avg. 1971(4)	114.0	4.12		3.94
Annual Avg. 1972(4)	117.9	4.49		4.21
Annual Avg. 1973(4)	125.9	4.82		4.48
Annual Avg. 1974(4)	153.8	5.43		4.85
Annual Avg. 1975(4)	171.5	6.13		5.37
Annual Avg. 1976(4)	182.3	6.75		5.89
Annual Avg. 1977	195.1	7.27	7.66	6.39
Annual Avg. 1978	209.4	8.26	8.56	7.01
July 1978	210.1	8.29	8.62	7.05
Aug 1978	211.4	8.43	8.66	7.06
Sept 1978	212.5	8.59	8.74	7.13
Oct 1978	214.7	8.64	8.83	7.19
Nov 1978	216.0	8.74	8.86	7.22
Dec 1978	217.2	8.76	8.97	7.28
Jan 1979	220.0	8.75	9.01	7.32
Feb 1979	222.5	8.85	9.02	7.32
Mar 1979	225.4	8.88	9.11	7.36
Apr 1979	229.0	9.07	9.49	7.50
May 1979	231.6	9.09	9.14	7.46
Jun 1979	234.0R	9.12	9.43	7.52
Jul 1979	237.2	9.32	9.57	7.60
Aug 1979	240.3	9.38	9.70	7.65
Sept 1979	243.8	9.61P	9.80P	7.71P
Oct 1979	248.5			7.77P

(1) Final revisions to 1977 data are as indicated. Producer Price Indexes are now routinely revised four months after they are first released to reflect the availability of late reports and corrections by respondents. Source: Bureau of Labor Statistics, *Producer Prices and Price Indexes*, Table 6. (Formerly *Wholesale Prices and Price Indexes)*

(2) Source: Bureau of Labor Statistics, *Employment and Earnings*, Table C-2.

(3) Monthly data for 1977 and 1978 appear in Report No. 125, dated December 31, 1978.

(4) Monthly data for these years appear in Section 10 of Report No. 107, dated June 30, 1977.
P = Preliminary
R = Revised

MARKET OPPORTUNITIES

Market Opportunities are *active* inquiries in the uranium market to buy, sell, borrow or lend. The data presented in this section are in no way intended to be indicative of the entire uranium market for the time period covered.

SUPPLY

Uranium Available for Sale

Delivery Year	Pounds U_3O_8 (1000's)	Nuexco Reference Number	Remarks
1979	650	1325	
	350	1270	
	100	1292	
	500	1314	
	100	1274	
	100	1319	
1980	300	1274	
	350	1284	
	500	1324	
	500	1285	
1981	100	1306	
	300	1274	
	300	1286	
	500	1324	
1982	300	1274	
	200	1306	
	300	1286	
	200	1315	
1983	300	1286	
	200	1306	

Uranium Available for Loan

Delivery Year	Return Year	Pounds U_3O_8 (1000's)	Nuexco Reference Number	Remarks
1979	1982	725	1175	UF_6
	1983	1000	1196	
	1983	1000	1136	UF_6
	1983	1000	1239	UF_6
	1983	700	1234	

MARKET OPPORTUNITIES

DEMAND

Inquiries to Purchase Uranium

Delivery Year	Pounds U_3O_8 (1000's)	Nuexco Reference Number	Remarks
1979	500	1323	
1980	350	1317	
	800	1268	
	100	1300	
1981	500	1228	
	200	1207	
	800	1260	
1982	300	1146	
	300	1227	
	200	1207	
	500	1228	
	400	1321	
1983	400	1321	
	250	1322	
	500	1228	

Inquiries to Borrow Uranium

Delivery Year	Return Year	Pounds U_3O_8 (1000's)	Nuexco Reference Number	Remarks
1979	1982	500	1121	
	1982-85	500	1135	
	1984	1000	1220	
	1983	1000	1240	

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NUCLEAR EXCHANGE CORPORATION

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EXECUTIVE SUMMARY & INDUSTRY OVERVIEW
NUEXCO REPORT NO. 136
Prepared Especially for Upper and Middle Management

This month's Report analyzes the supply/demand balance of natural uranium in the US. A continuation of current US buyer inventory policies could lead to a cumulative market for additional imports and new US production of about 100 million pounds U_3O_8 through 1990.

In Australia, the Ranger partners have announced a long-term sale of 5 million pounds U_3O_8 to Korea, for delivery from 1983-1992. This is the first new contract endorsed by the Australian government since 1972.

Six and a half million pounds of the output of the Blizzard claims in Canada have also been purchased by Korea. The property is estimated to contain more than 10 million pounds U_3O_8. Production is expected to begin in 1983.

In the current US spot market, supply far outweighs demand. Active inquiries for the balance of 1979 show a total of 1.8 million pounds U_3O_8 available, with inquiries to purchase only half a million pounds. Additional spot material, perhaps in significant quantity, is very likely to appear on the market in the next several months.

The continuing downward trend in the market is reflected by the **Exchange Value**, which dropped $1.20 in one month to $41.00 per pound U_3O_8. Demand remains low, as many buyers either see little driving force to build inventory or have already completed their inventory-building programs. The weakened market is of immediate concern to utilities seeking to unload excess inventory, and to those taking delivery under contracts with pricing mechanisms which have produced prices in excess of current market at time of delivery. **Transaction Value** declined slightly to $43.50.

This month's *Topical Essay* discusses spot and other markets.

Raw Materials offers the first of two articles on by-product uranium production from phosphate.

This Executive Summary may be reproduced for internal distribution.

11/30/79

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MONTHLY REPORT TO THE NUCLEAR INDUSTRY

NO. 137

DECEMBER 31, 1979

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NUEXCO

MONTHLY REPORT TO THE NUCLEAR INDUSTRY

No. 137 December 31, 1979

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TRANSMITTAL ii

THE URANIUM MARKET
PUBLIC AND GOVERNMENT POLICY 1.0
AUSTRALIA 1.1
CANADA 1.1
JAPAN 1.1
UNITED STATES 1.2
PRICING 1.2

TOPICAL ESSAY
URANIUM PRICES & PRICE MECHANISMS 2.0

RAW MATERIALS
BY-PRODUCT URANIUM FROM PHOSPHATE—PART II 3.0

STATISTICAL DATA
EXCHANGE AND TRANSACTION VALUES 4.0
LOAN USE CHARGE RATE 4.3
CURRENT TRANSACTIONS 4.4
GOVERNMENT STATISTICS 4.5

MARKET OPPORTUNITIES
SUPPLY 5.0
Uranium Available for Sale
Uranium Available for Loan
DEMAND 5.1
Inquiries to Purchase Uranium
Inquiries to Borrow Uranium

ANNUAL SUMMARY — 1979
REPORT HIGHLIGHTS OF 1979 6.0

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TRANSMITTAL 12/31/79

A modest additional supply of 1980 Nuexco pocket calendars is still on hand. Calendars are available on request.

We wish all of our Subscribers a happy and prosperous 1980.

URANIUM MARKET

PUBLIC AND GOVERNMENT POLICY

Recent events involving *Iran* constitute one of those special situations in which national perspective is brought into focus more realistically. Many areas of public policy, including energy policy, may be importantly affected. One result is likely to be a stronger emphasis on concrete energy programs utilizing proven practical approaches, and less willingness to base programs on esoteric hopes. Cutbacks in, and added threats to, the oil supply will necessitate more emphasis on practical solutions. Nuclear power and conservation should both move up a notch in governmental priorities.

None of this will significantly increase either short-term uranium demand or the number of *new* nuclear plants ordered in the next few years. However, a slowing, perhaps even a trend toward reversal, of legal and regulatory barriers may become more in vogue.

South Africa is currently enjoying an economic boom credited mainly to:

1. Record gold prices, which provide adequate domestic capital for industrial development. Dependency on foreign investment has been greatly reduced.
2. Prime Minister P. W. Botha has been, and is continuing to be, more progressive than expected. Confidence in South Africa's future is growing. There is more optimism that the nation's social problems will eventually be solved. Mr. Botha has been able to maintain the confidence of the most conservative political bloc while, at the same time, gaining enthusiastic support from the moderate bloc, which did not support his appointment.
3. National self-sufficiency has increased, partly as a result of needs arising from past political semi-isolation. South Africa has inventoried at least a two-year supply of oil. A coal liquifaction plant, Sasol I, has successfully operated for several years. Construction of Sasol projects II and III is progressing on schedule. Roughly half of the nation's oil supply will soon be drived from coal. As far as energy is concerned, South Africa may already be less vulnerable to external conditions than other industrialized nations.

Because uranium is a by-product of a strong gold mining industry, and long-term investment is now more readily available, South Africa probably enjoys the strongest uranium *production* position of any major producer nation. However, its *marketing* position continues to be affected by political considerations. On balance, however, the South African position appears substantially stronger today, compared to two or three years ago.

Australia is experiencing an economic boom based on energy and resources in general. Prime Minister Fraser's free enterprise-oriented policies are dismantling barriers to resource development and increasing incentives for domestic and foreign investment.

The uranium industry continues to move forward with concrete action in respect to mining and production. However, competition for Australian capital and manpower is increasing as interest in other resource development expands. Moreover, market conditions have tempered uranium development expectations. It presently appears unlikely that Australian production capability will expand more rapidly, and to a greater extent, than world markets can absorb.

In a speech given recently in San Francisco, Deputy Prime Minister Anthony strongly restated his government's disapproval of US antitrust actions. He claimed that the US is seeking to enforce laws which seriously compromise international commerce. He criticized the US for acting according to an antitrust double standard, since acts for which Australian uranium companies are being sued occurred during a US-imposed prohibition on imports of uranium for use in domestic reactors. That action, he pointed out, closed 70 percent of the market to non-US producers.

In the *UK*, legislation designed to prohibit the enforcement of multiple damage judgments and the granting of certain rights of recovery against British companies penalized under US antitrust laws is currently passing through Parliament. Although it has not yet become law, the bill is attracting attention in other nations, and may serve as a model for similar legal actions.

The government authorized selection of Westinghouse Electric Corporation technology for the country's next nuclear power plant. The project will be part of Britain's newly announced nuclear power expansion program, and construction is scheduled to begin in 1982. Nuclear power output is being accelerated by the government to meet energy demands when North Sea oil production begins to decline in the 1990's.

AUSTRALIA

It was announced this month that the Australian federal government will sell its 50 percent share in Ranger to Peko-Wallsend Ltd. Peko will pay the government A$125,000,000, refund the A$40,000,000 already spent by the government, and relieve the government of commitments to finance 72.5 percent of the capital cost of the project (total project development cost is currently estimated at A$315,000,000, exclusive of the A$125,000,000 payment by Peko to the government). A new company, Energy Resources of Australia Ltd. (ERA), will be formed, which will hold a 75 percent interest in the Ranger project (the 25 percent now held by Peko in its joint venture with Electrolytic Zinc plus the 50 percent to be acquired from the government). Peko will own 50 percent of ERA's equity, Australian investors will be offered 25 percent, and non-Australian uranium consumer interests will hold the remaining 25 percent. Despite recent press reports, no final decision has been made regarding the distribution of equity among the non-Australian consumers, although Japan, the FRG and the UK are seen as front runners.

The sale of the government's share to one of the two existing partners and the participation of overseas consumers in the equity of the Ranger project are seen as positive signs that will ensure that there are markets for the uranium and that the project continues to move forward on a timely and sound financial basis.

CANADA

Public hearings will begin in January 1980 in Saskatchewan to consider all facets of uranium development in the province. The two primary projects to be discussed are the Key Lake project led by Saskatchewan Mining Development Corporation, and the UF_6 conversion facility proposed by Eldorado Nuclear Ltd. for the Warman district near Saskatoon. The hearings are expected to continue through March. Decisions concerning continued development should be handed down later in the year, possibly by early summer. Rulings are expected to favor continued uranium development, although an anti-nuclear faction remains strong in Saskatchewan and within the province's ruling political party, the National Democratic Party (NDP). At a recent federal convention of the NDP, a motion for a moratorium on uranium development was defeated, but only by a margin of 537 to 402. However, Saskatchewan Premier Allan Blakeney had made it clear early in the convention that his government's position would not be affected by any policies the federal party adopted.

JAPAN

Japan's nuclear and uranium positions were covered in considerable detail in Nuexco's Topical Report published in September 1979, entitled *Uranium Supply and Demand in Japan.* Since then, three further developments of significance have occurred. First, a Japanese utility concluded two purchase contracts providing for delivery of a total of 4,400,000 pounds U_3O_8 for delivery in the 1980's. Prices in both agreements are related to then-prevailing market conditions.

Second, price negotiations between Japanese buyers and overseas sellers for 1981 deliveries have resulted in settlement prices considerably below the sellers' original expectations. Initial asking prices were more than $50 per pound U_3O_8, but settlements achieved were in the range of $44 to $46 per pound. It appears Japanese buyers are sensitive to both the current price decrease and to the buyers' stronger position in the market.

Finally, the sale of the Australian government's share of Ranger to Peko-Wallsend Ltd. will involve Japanese utilities purchasing a part of Peko's 75% interest in the Ranger project. This will ensure additional long-term contracts for the supply of Ranger uranium to Japan. Thus, Japan's already substantial uranium inventories would be increased, making Japanese utilities even less likely candidates for additional purchases during the 1980's.

UNITED STATES

The US Internal Revenue Service has issued a letter ruling (LTR 7943161) concerning the tax consequences of a producer borrowing uranium for resale. The ruling holds for the case in question that the borrower realizes no gain or loss for income tax purposes when it borrows uranium from a lender. The subsequent sale by the borrower will qualify as a short sale, for tax purposes, and the borrower will again incur no gain or loss at the time of sale. It is only when the borrower repays the uranium to the lender that the short sale will be considered by the IRS as a closed transaction for tax purposes, and gain or loss will be recognized at that time. The tax ruling will facilitate US producers in borrowing uranium, either to make up shortfalls or as an alternative to borrowing in the money market.

The question of overlapping Nuclear Regulatory Commission (NRC) and state jurisdiction regarding uranium mill tailings in agreement states (see Nuexco Report No. 133) has been resolved by Congress. (The law, enacted as a rider to the Surface Transportation Assistance Act signed by the President in late 1979, provides the NRC with authority to monitor and assist cognizant agencies in agreement states in bringing state regulations concerning mill tailings up to the level of equivalent federal regulations during the three-year interim period set forth in the federal uranium Mill Tailings Act of 1978.) The three-year grace period, which expires November 8, 1981, is provided in the Mill Tailings Act to allow for such upgrading of regulations by the states. It now is clear that there is no concurrent NRC jurisdiction during the grace period.

Governor Bruce King of New Mexico said he will submit a proposal to the state legislature in January 1980 to increase the severance tax on uranium and other energy minerals. The Governor did not say how much of an increase he will seek for uranium, but he did express a desire to raise another $65,000,000 to $75,000,000 per year in energy taxes. The severance tax on uranium in New Mexico was last increased in 1977.

A sliding scale was enacted, with the highest bracket at $1.99 per pound U_3O_8, plus 12.5 percent of the incremental selling price above $40.00 per pound U_3O_8. The 1980 New Mexico legislature session will last only 30 days and will be confined to revenue and tax matters.

The New Mexico Environmental Improvement Board has adopted stricter state regulations for the uranium industry. These include a ban on construction of uranium mills until a license is issued regarding mill tailings disposition, and the requirement for a half-mile buffer zone around tailing sites until such time as the site becomes inactive and reclaimed. It also requires bonding of a mill license holder to ensure tailings reclamation and allows for increased public participation in the licensing process for uranium mills.

Three spot transactions involving US sellers closed this month at prices close to Exchange Value. These transactions notwithstanding, there remains a substantial imbalance in the near-term market. Totals of active inquiries to purchase and sell in 1980, listed in the *Market Opportunities* section of this Report (pp 5.0 and 5.1), are as follows:

Thousands of Pounds U_3O_8	
Available for Sale in 1980	Inquiries to Purchase in 1980
3,750	2,450

Of the total available for sale in 1980, approximately one-half involves inventory sellers. It has largely been this influence of inventory sellers that has been responsible for the downward pressure on the dollar price of uranium in recent months. The extent to which these sellers are determined to sell will probably determine the course of the uranium market in the near future.

PRICING

The **Exchange Value** moved downward slightly this month to $40.75 per pound U_3O_8 The decrease from last month represents additional pressure on the market by uranium inventory holders wishing to make spot sales.

From the standpoint of the producer, especially the US producer, the current uranium market outlook is bleak. While prices are falling, costs are escalating, and producers are rapidly being caught in the squeeze. The principal reasons for increased production costs are:

1. *Higher wages.* This is primarily due to inflation and to competition for miners, especially underground miners, among mineral producers.
2. *Lower Grade.* Grade is falling off dramatically in the US: the average uranium ore grade for 1979 will be considerably lower than that of 1978, and is anticipated to be even lower in 1980.
3. *Regulatory compliance.* Meeting environmental, health and safety regulations is becoming increasingly expensive.
4. *Higher taxes.* Most uranium mined in the US is now subject to substantial severance taxes, and these taxes will probably be increased.

URANIUM MARKET

As costs increase, uranium prices continue to slip. The near-term outlook for producers is clouded by competition in the market from utilities selling inventories. Also hampering producers in both the near-term and longer-term markets is the reluctance of buyers to sign contracts which may eventually require them to pay higher than the generally perceived market price at the time of delivery. This makes it difficult for producers to justify making large expenditures for mine development, since they lack reasonable assurance that they will be able to earn a return on the funds invested. This applies even more strongly to potential new US producers.

The extent to which the current market appears unfavorable to producers is often masked by the rapid rise in the price of uranium during the 1974-75 period. However, that price rise started from the extremely depressed market of the early 1970's. In addition, inflation and other factors have largely wiped out the gains made during the strong seller's market of 1974-75. To better understand the current position of the US uranium industry, it is instructive to work through a simple exercise to estimate whether today's Exchange Value is comparable to what might be considered an incentive price for a healthy and vigorous uranium industry.

One method for making such a determination would be to compare today's situation to a previous period in which the uranium industry was generally thought to be healthy, and the price was considered an incentive price to maintain or expand production levels. The year 1960 is generally thought of as a good year for the industry. At that time, the average price paid by the AEC was $8.60 per pound U_3O_8. Adjustments need to be made to this price to account for changes in the industry since 1960:

1. *Ore Quality.* The average ore grade mined in the US during 1960 was 4.8 lbs U_3O_8 per ton. The average grade for 1979 is expected to be less than half that. Since mining and milling costs are directly related to grade, a current price of at least twice the 1960 price, or $17.20 per pound U_3O_8, would be required to provide the same degree of incentive. (In addition, ore deposits are deeper today than in 1960, especially for most potential new US production, but this effect is neglected here.)

2. *Inflation.* The effects of inflation since 1960 can be estimated using US government indexes. (Because the late 1950's and early 1960's were years of very low inflation, and because prices paid by the AEC were relatively constant during that period, the results of this simple calculation are not very sensitive to the year chosen as a base point.) The Producer Price Index for Industrial Commodities increased approximately 250 percent from 1960 to September 1979. The Average Hourly Earnings in Metal Mining (SIC 10) increased approximately 350 percent in the same period. Thus, the average increase in the cost of labor and materials for uranium mining from 1960 to late 1979 may be considered to be about 300 percent.

3. *Other.* Another factor to be considered is the addition of health, safety and environmental costs to the cost of uranium production. Nuexco estimates that the total added cost involved in these factors for a US underground mine is about $5.00 per pound U_3O_8. Finally, the added cost of severance taxes is one to two dollars per pound or more, depending on the jurisdiction and selling price.

Thus, the late 1979 selling price equivalent to $8.60 in 1960 would be considerably higher than current Exchange Value, i.e. $8.60 x 2 (ore quality) x 3 (inflation) + health, safety and environmental costs + taxes. It should be emphasized, however, that this simple calculation is only intended to translate what was once shown to be an incentive price into today's dollars and today's mining conditions. The purpose is for comparison only, to demonstrate that a price level equal to today's Exchange Value may not, in fact, be a strong incentive to maintain a healthy domestic production industry, although some existing or under-construction operations might have attractive rates of return at prices at or below current Exchange Value. However, it is uncertain how many new US production centers will move forward under current conditions. Also, it is likely that some US output considered "firm production," as discussed in Reports Nos. 133 through 136, will not, in fact, be produced, because economically marginal facilities may be cut back. The ultimate result may be a shift in uranium production to non-US producers, thus generally increasing dependence of the US on imported uranium.

The **Transaction Value** moved down substantially this month to $42.30 per pound U_3O_8. The principal reason for the change was the inclusion in the Transaction Value calculation of the qualifying transactions which closed this month, thus allowing several old transactions to drop from the sample of at least ten transactions totaling ten million pounds U_3O_8. However, the time period still extends over six months; thus the Transaction Value still lags the Exchange Value.

The **Loan Use Charge Rate** remained at seven percent. One loan transaction closed this month at a use charge rate consistent with the Nuexco Loan Use Charge Rate, and several lots of uranium are currently available for loan at comparable rates.

URANIUM PRICES & PRICE MECHANISMS

This is the fourth essay in a series on various aspects of the uranium market.

Introduction

Uranium prices and price mechanisms are at once the most discussed, most argued about, perhaps most interesting and, for obvious reasons, most sensitive subjects in the uranium market. Accordingly, the following discussion focuses on definitional, philosophical and procedural considerations, as opposed to specific prices.

Types of Prices

Defining certain terms provides a frame of reference. The types of prices defined below are sometimes used in combination, especially in long-term contracts.

1. *Fixed Price:* A fixed price is one that is established at the time of contracting. Fixed prices may take a number of forms. The most common include:

   a. A single, fixed price applicable to a single delivery, such as *X* dollars per pound U_3O_8 for 100,000 pounds U_3O_8 to be delivered in June 1980; or single, fixed prices applicable to a series of deliveries, such as *X* dollars per pound U_3O_8 for delivery of 50,000 pounds U_3O_8 per month, May and August 1980.

   b. A series of fixed prices for a series of deliveries. For example, deliveries of 50,000 pounds U_3O_8 per month, May and August 1980, at prices of *X* dollars per pound U_3O_8 in May and *Y* dollars per pound of U_3O_8 in August.

   c. A single price escalated at a fixed annual or monthly rate, from the date of contract to the date of delivery. For example, *X* dollars per pound U_3O_8 escalated at *Y* percent annually. This approach can be applied to a single delivery or to a series of deliveries.

In each case, the exact price to be paid is known at the time of contracting, or can be calculated with absolute certainty.

2. *Base Price Adjusted:* This is a price which is adjusted on some basis other than a pre-established fixed escalation rate. The most common form of adjustment involves the use of government-published indexes. Those most frequently used in the United States are the labor and materials indexes published by the Department of Labor's Bureau of Labor Statistics. Example of commonly used labor indexes are:

   a. Average Hourly Earnings, Metal Mining (SIC 10).

   b. Average Hourly Earnings, Primary Nonferrous Metals (SIC 333).

   c. Average Hourly Earnings, Chemicals and Allied Products (SIC 28).

   Examples of other commonly used indexes are:

   a. Producer Price Index, Industrial Commodities.

   b. Implicit GNP Deflator (published quarterly by US Department of Commerce).

Most of these indexes are reprinted on page 4.5 of this Report. Similar indexes are published in Australia, Canada and South Africa.

3. *Cost Related Price:* This is a price based on the seller's cost of production, plus some margin for return on investment. The profit margin may be a fixed amount per pound U_3O_8, a fixed amount adjusted for inflation, a percentage of cost, or may even be expressed as a percentage return on investment. This has a number of implications. The buyer will usually have the right to audit the seller's books of account. The necessity of precisely defining cost can lead to difficult negotiations and lengthy contracts. A further complication often comes from the buyer's attempting to link the producer's profitability to production cost to serve as an incentive, or by some other means, to ensure that there are no disincentives to efficient operation on the part of the seller.

4. *Floor Price:* This term is used to describe the minimum price under contracts which provide more than one basis for price determination. Floor price itself may be a fixed price, a base price adjusted, or a cost-related price.

5. *Market Price:* The term *market price* is subject to greater variation and misunderstanding than any of the others. A dictionary definition is that market price is the actual price at which a given commodity is currently sold, or has recently been sold, in the open market; that is, not a forced sale, but a sale in the usual and ordinary course of trade and competition, between sellers and buyers equally free to bargain, as established by records of late sales. The latter definition may be more akin to what is normally thought of as a *spot market price*. In the uranium market, however, a contract providing for sales

at market price (also known as *world market price, world price, fair market price,* etc.) is usually designed to establish, at the time of the contract, ground rules for determining, at or near the time of actual delivery of the material, the price to be paid. It can be used alone or in conjunction with a floor price.

Two basic methods of determining market price are in use today. One is to refer to a published price available to both parties. The second is to have the concerned parties negotiate a price. A contract in which market price is negotiated will usually contain guidelines for carrying out the negotiation, including a method for determining the contract price if the parties are unable to establish one through negotiation. Often a method is provided for choosing an expert or panel of experts which will determine the price in the event the parties fail to reach agreement by negotiation. The contract will usually delineate what evidence is acceptable to the parties for consideration in setting the price. While there are several methods for determining market price, the usual objective expressed in most long-term contracts is for the parties to achieve, for *that* contract, and for the specific conditions pertaining to it, an appropriate price at the time of delivery.

Uranium vs. Other Commodities

Uranium, unlike stocks, bonds, many metals and agricultural products, has no centralized marketplace where market makers buy and sell it. Uranium has nothing akin to the markets provided for stocks and bonds by the New York Stock Exchange and other exchanges; for copper and other metals by the London Metals Exchange (LME), or for wheat and other agricultural products by the Chicago Board of Trade. For example, in the stock market, a specialist will buy and sell shares of a given stock at "bid" and "asked" prices that the specialist makes available to all market participants. The level of the bid and asked prices, and the spread between them, depend on supply and demand for that particular stock. Likewise in the commodity exchanges, fungible commodities are bought and sold in standard lots using standard contracts. Each business day, bid and asked prices are published, as well as transaction prices. For many commodities, direct long-term transactions between buyer and seller are priced in accordance with the published exchange price at the time delivery is made, even though the transaction otherwise has nothing to do with the exchange. For example, copper is usually sold under contracts based on the LME price even though only a very small percentage of world copper production is physically traded through the LME.

The uranium market is different in that there is no market maker for uranium. Consequently, there is no direct equivalent in the uranium market of an LME quote. There has been much speculation about why such a market for uranium has not developed. Certainly uranium is a fungible commodity in the sense that a "standard concentrate" can be produced (unlike coal and oil, the characteristics of which vary widely among production lots and producers), and transportation is an unimportant factor in the price. There are several possible explanations for the lack of uranium market makers:

1. *Licensing:* Since in most countries the possessor or uranium must be licensed, a market maker might have difficulty in accepting delivery under a purchase contract if the material has not already been resold at the time of delivery.

2. *Government Controls:* The governments of most uranium-producing countries maintain end-use controls over uranium, reducing its fungibility. Some governments require that sales of uranium be made only to end users. Such regulations make it difficult for a market maker to operate.

3. *Conversion Contractors:* Historically, most uranium production has been shipped immediately to conversion facilities. Contractual relationships with the conversion contractors often greatly restrict the free marketability of uranium located at these facilities, and thus would be disadvantageous to a potential market maker.

4. *Limited Market:* Natural uranium currently has only one commercial use, as a power reactor fuel. Thus, there is only one class of customer, with relatively few members. Also, several brokerage firms operate extensively in the world-wide uranium market, thus making uranium easier for producers to sell and utilities to purchase. In any event, the need for a formal market maker in uranium has not been apparent, and the lack of such a real need is probably the most important reason why there are, in fact, no market makers. While a few traders in uranium buy and sell for their own account, they do not do so in an organized fashion, with published bid and

asked prices. Rather, the traders usually operate informally, buying and selling when particularly good opportunities present themselves.

Since there is no organized market for uranium, there is thus no equivalent to an LME price for uranium based on a specific set of selling conditions. However, many buyers and sellers world-wide accept Nuexco's Exchange Value as an equitable reflection of conditions for spot and near-term transactions.

BY-PRODUCT URANIUM FROM PHOSPHATE—PART II

Introduction

Marine phosphorite deposits in the Western US are of increasing economic interest due to the demand for industrial and agricultural phosphate products. Uranium recovery from phosphoric acid was not a serious consideration until four to six years ago. Presently, one company is scheduled to begin recovering uranium by early 1980 and two are in the advanced stages of recovery preparations which will utilize phosphate rock mined in southeastern Idaho.

The principal phosphate deposits of the Western US are restricted to the Phosphoria Formation of Permian Age. The formation is considered to cover an area of about 135,000 square miles in Montana, Idaho, Wyoming and Utah. Figure 1 shows the approximate extent of the Phosphoria Formation and the main areas of economic development.

The Phosphoria Formation varies in thickness from about 200 to 1500 feet throughout portions of the four states. In general, the entire depositional sequence, including the Phosphoria Formation, has been intensely folded and faulted into rugged terrain characterized by northwest-trending mountain ranges. The Phosphoria Formation is primarily situ-

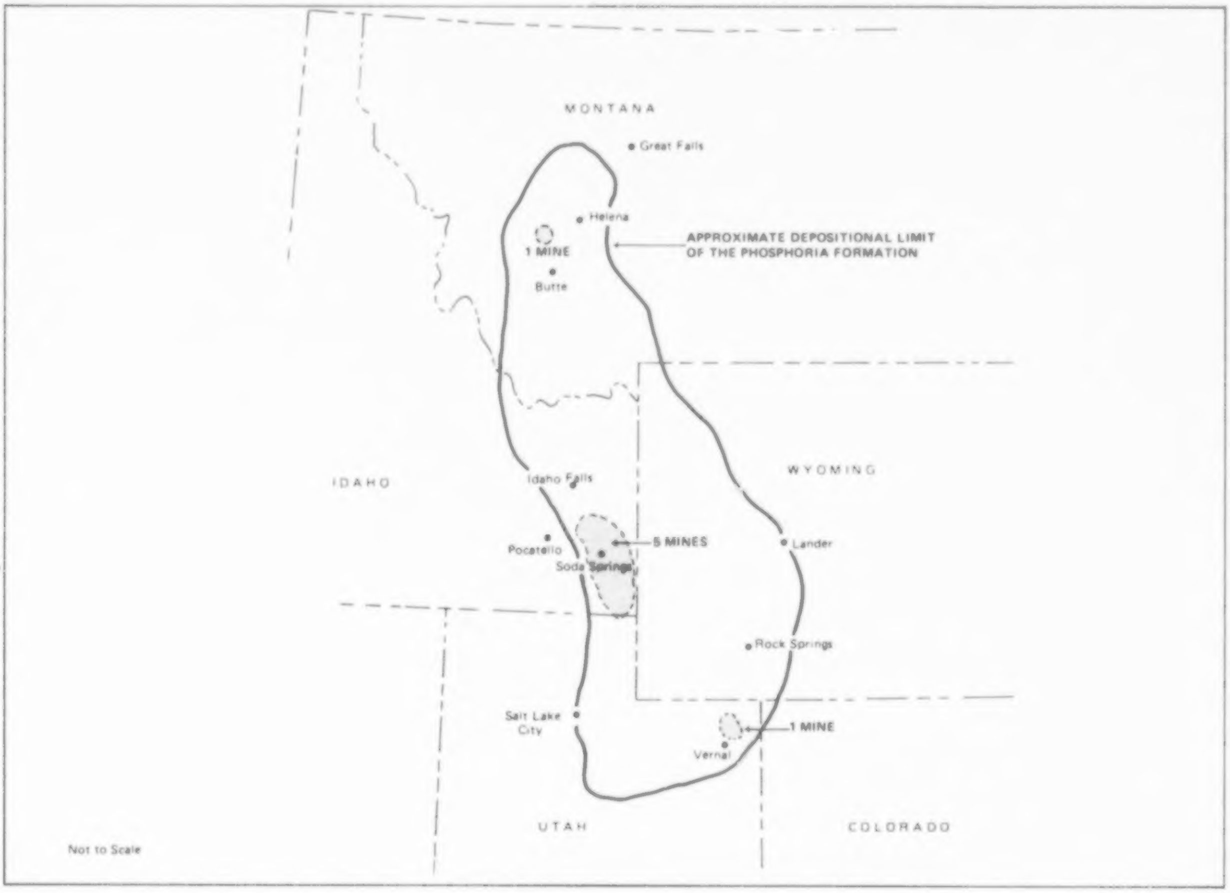

MONTANA
Great Falls
Helena
1 MINE
Butte
APPROXIMATE DEPOSITIONAL LIMIT OF THE PHOSPHORIA FORMATION
IDAHO
Idaho Falls
WYOMING
Pocatello
5 MINES
Soda Springs
Lander
Rock Springs
Salt Lake City
1 MINE
Vernal
UTAH
COLORADO
Not to Scale

Figure 1
GENERAL LOCATION OF WESTERN PHOSPHATE FIELD
SHOWING MAIN AREAS OF ECONOMIC INTEREST

ated at varying altitudes between 3,000 and 10,000 feet above sea level.

The Formation is composed of five members, of which the lowermost—the Meade Peak Phosphatic Shale Member—contains the only significant phosphate resources of the district. The phosphorite deposits occur primarily near the top and botton of the Meade Peak Member. The highest concentration of phosphate is 30 to 36 percent, as it occurs in the bottom ore zone, which is 30 to 60 feet thick in southwestern Idaho. The phosphate content decreases to 28 percent or less as the ore zone thins to about 20 feet going northward into Montana and southward into Wyoming and Utah. The upper phosphate zone is about 30 feet thick and is consistently lower in phosphate content—from 30 percent P_2O_5 in isolated occurrences to a more common concentration of 15 to 20 percent throughout. About 80 percent of reserves recoverable, given current economics and technology, occur in the lower ore zone in southeastern Idaho (see Figure 1). The remaining members of the Phosphoria Formation contain minor amounts of phosphate, the most important of which is the Retort Phosphatic Shale Member. It is 40 to 80 feet thick and contains phosphate occurrences of from less than 2 percent to 25 percent. It is mined only on a local basis.

Mineral Occurrences

The phosphate occurs primarily as fine-grained pellets of carbonate fluorapatite. The percentage of phosphate content has been upgraded as the result of alteration of the apatite. Essentially all phosphatic beds of the formation contain uranium in amounts of 0.001 to 0.03 percent U_3O_8 in association with the fluorapatite. As the percentage of phosphate content increases, so does the uranium. Thus, the highest percentage of contained uranium occurs in the lower ore zone of the Meade Peak Phosphatic Shale Member of the formation.

Vanadium is common to western phosphorite deposits. It is closely associated with the fluorapatite, and its percentage content is likewise increased as the carbonates are removed by rock alteration. The amount of V_2O_5 in the phosphate rock is approximately 0.18 to 0.25 percent. However, only about half of the contained vanadium enters the acid stream in the production of phosphoric acid.

Resources of Western Phosphates

Currently recoverable identified phosphate reserves are estimated to be 6,000,000,000 to 8,000,000,000 tonnes, most of which is located in southeastern Idaho. Such reserves are limited to depths of less than 1,000 feet, due to the steep dipping and highly folded and faulted beds. On the other hand, hypothetical resources are projected to depths of three to five thousand feet in certain areas, and are roughly estimated at 10,000,000,000 tonnes.

Phosphate Production

Phosphate from the Phosphoria Formation amounts to about 11 percent of total US production. Actual mine production of phosphate rock totaled approximately 6,500,000 tonnes in 1978. Of that total, 2,200,000 tonnes were committed to wet-process phosphoric acid production; the remaining 4,300,000 tonnes were converted to industrial and agricultural phosphate products via the elemental phosphorous process. Uranium contained in all phosphate rock mined in the US in 1978 is estimated at 1,400,000 pounds U_3O_8. The amount of uranium contained in the wet-process phosphoric acid, none of which was recovered, is estimated at 485,000 pounds U_3O_8.

Marine Phosphorites Outside the US

Almost 60 percent of the world's identified reserves are located in western and northern Africa (see Part I of this article, Table on pg. 3.2, in Report No. 136). Of that amount, 80 to 90 percent occurs in northwestern Morocco. Phosphate rock mined at two production centers in Morocco totaled almost 20,000,000 tonnes in 1978. Essentially all mine production was exported; phosphoric acid production for domestic use was less than 300,000 tonnes. The total phosphate rock mined contained about 8,400,000 lbs U_3O_8, none of which was recovered.

In Brazil, study is underway to determine the economic feasibility of extracting both phosphates and uranium from deposits near Itataia in the state of Ceará. Petrobrás Fertilizantes SA and Nuclebrás will spend $270,000 on the study with the expectation of producing within four to five years.

STATISTICAL DATA

EXCHANGE VALUE — $40.75/lb U_3O_8

DEFINITION

The Exchange Value is Nuexco's judgment of the price at which transactions for significant quantities of natural uranium concentrates could be concluded as of the last day of the month.

DERIVATION

Nuexco bases the Exchange Value upon:

A. Data from recently completed transactions.
B. Data from pending transactions.
C. Firm bids to buy and firm offers to sell.
D. Prices purchasers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy, and prices sellers have expressed a willingness to accept, but for which Nuexco is not aware of firm offers to sell.

COMMENTS

Nuexco does not consider the following in determining the Exchange Value:

A. The price of uranium delivered or to be delivered under old contracts.
B. The price of uranium delivered in connection with contract renegotiations or other than arm's length transactions.

TRANSACTION VALUE

$/lb U_3O_8	Millions of Pounds	Number of Transactions	Number of Months
42.30	2.1	13	6

DEFINITION

The Transaction Value is a weighted average price of recent transactions, and is based on prices paid for U_3O_8 in transactions closed within the previous three-month period and for which delivery was scheduled within one year of the transaction date. At least ten transactions totaling at least two million pounds U_3O_8 are included in each calculation, or the sample time is extended as necessary to include these minima. Foreign currencies are converted to US dollars as of the transaction date.

STATISTICAL DATA

Figure 1
HISTORICAL EXCHANGE VALUES

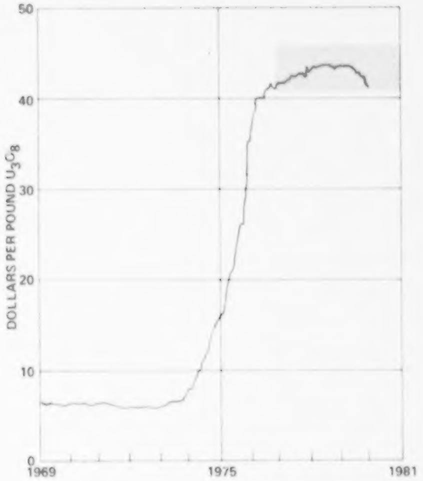


Figure 2
HISTORICAL TRANSACTION VALUES

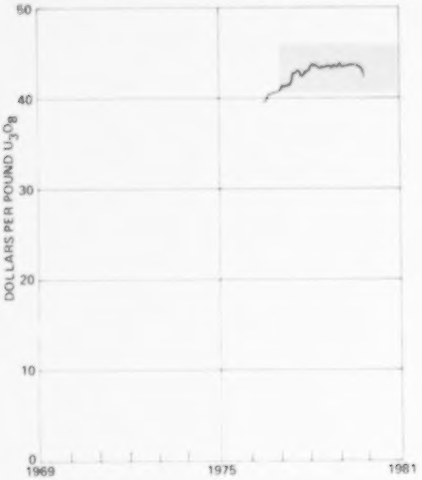
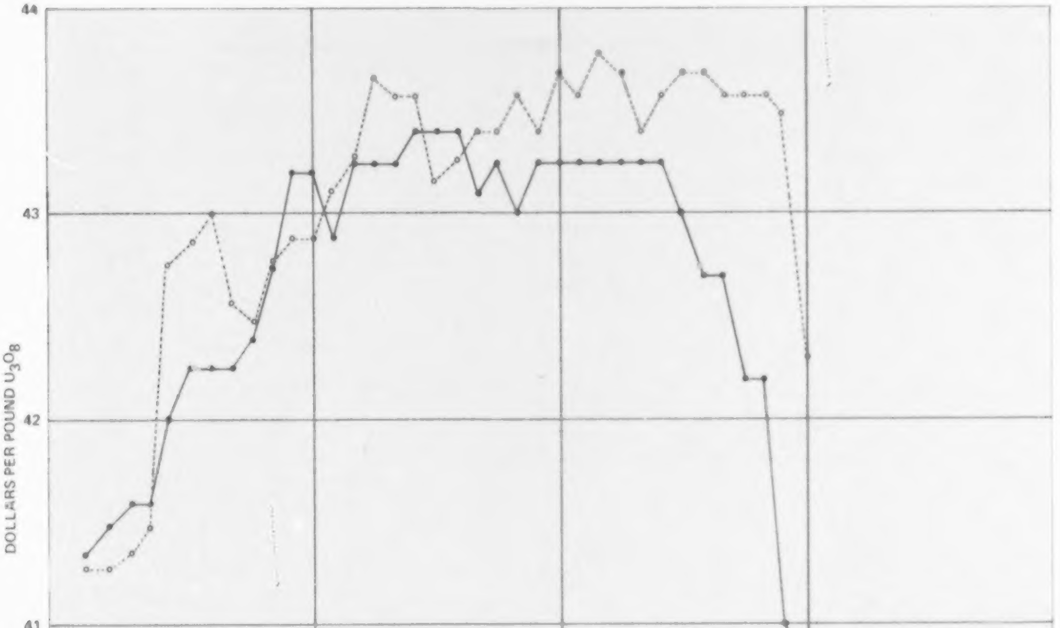


Figure 3
RECENT EXCHANGE AND TRANSACTION VALUES



EXCHANGE VALUE
US Dollars/lb U_3O_8

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1968	–	–	–	–	–	–	–	6.35	6.35	6.40	6.45	6.50
1969	–	6.35	6.10	6.10	6.25	6.25	6.20	6.20	6.15	6.15	6.15	6.20
1970	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.20	6.15	6.15	6.15	6.15
1971	6.20	6.20	6.20	6.20	6.15	6.05	6.00	5.95	5.95	5.95	5.95	5.95
1972	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95
1973	5.95	6.00	6.10	6.20	6.45	6.50	6.50	6.50	6.50	6.50	6.75	7.00
1974	7.70	7.90	8.00	9.00	9.50	10.50	11.50	12.00	12.50	14.00	14.75	15.00
1975	16.00	16.00	18.00	20.00	21.00	23.00	24.70	26.00	26.00	28.50	30.00	35.00
1976	35.20	37.00	39.25	40.00	40.00	40.00	40.00	40.40	41.00	41.00	41.50	41.00
1977	41.35	41.50	41.60	41.60	42.00	42.25	42.25	42.25	42.40	42.75	43.20	43.20
1978	42.90	43.25	43.25	43.25	43.40	43.40	43.40	43.10	43.25	43.00	43.25	43.25
1979	43.25	43.25	43.25	43.25	43.25	43.00	42.70	42.70	42.20	42.20	41.00	40.75

Note: See earlier Nuexco Reports for evolution of the definition of Exchange Value.

TRANSACTION VALUE
US Dollars/lb U_3O_8

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1976	–	–	–	–	39.60	39.70	39.70	40.40	40.30	40.60	40.70	40.70
1977	41.30	41.30	41.40	41.50	42.80	42.90	43.00	42.60	42.50	42.80	42.90	42.90
1978	43.10	43.30	43.70	43.60	43.60	43.20	43.30	43.40	43.40	43.60	43.40	43.70
1979	43.60	43.80	43.70	43.40	43.60	43.70	43.70	43.60	43.60	43.60	43.50	42.30

STATISTICAL DATA

EXCHANGE VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES*

Country	per lb U_3O_8 in Concentrates	per kg U_3O_8 in Concentrates	per kg U in Concentrates
US (dollar)	40.75	89.84	105.94
France (franc)	163.92	361.38	426.15
FRG (mark)	70.27	154.92	182.69
Japan (yen)	9,796	21,596	25,467
Switzerland (franc)	64.92	143.12	168.78
UK (pound)	18.26	40.25	47.46
Australia (dollar)	36.78	81.08	95.61
Canada (dollar)	47.77	105.32	124.20
Niger, Gabon (CFA)	8,196	18,069	21,307
South Africa (rand)	33.68	74.25	87.55

* Calculated using currency exchange rates published in the Wall Street Journal on the last business day of the month.

LOAN USE CHARGE RATE — 7.0%/year

DEFINITION

The Loan Use Charge Rate is Nuexco's judgment of the annual interest rate at which uranium loans could be concluded as of the last day of the month.

DERIVATION

Nuexco bases the Loan Use Charge Rate upon:

A. Data from recently completed or pending loan transactions.
B. Rates included in firm proposals to borrow or lend.
C. Rates that potential borrowers and lenders have expressed a willingness to pay or accept, but for which Nuexco is not aware of firm proposals.

STATISTICAL DATA

CURRENT TRANSACTIONS*

Ref	Delivery Period	Material & Approximate Quantity	Approximate Price as % of Current E.V.	Seller Group	Buyer Group	Remarks
1015	79	Less than 50,000 lbs U_3O_8	108%	Europe	Europe	UF_6; Not an arm's length transaction
1016	79	100,000 to 300,000 lbs U_3O_8	108%	Europe	Europe	Not an arm's length transaction
1017	79	100,000 to 300,000 lbs U_3O_8	100%	US	US	
1018	79	300,000 to 600,000 lbs U_3O_8	103%	US	US	
1022	80	50,000 to 100,000 lbs U_3O_8	98%	US	Pacific Basin	UF_6
1023	79	600,000 to 1,000,000 lbs U_3O_8	–	US	US	Loan; repayment in 1980

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* Transactions listed include not only those in which Nuexco was involved, but also all others of which Nuexco is aware.

US GOVERNMENT STATISTICS

	Producer Price Index—Industrial Commodities (1967 = 100)[1]	Gross Average Hourly Earnings of Production or Non-Supervisory Workers[2]		
		Metal Mining (SIC 10)	**Primary Non-ferrous Metals (SIC 333)[3]**	**Chemicals and Allied Products (SIC 28)**
Annual Avg. 1970[4]	110.0	3.98		3.69
Annual Avg. 1971[4]	114.0	4.12		3.94
Annual Avg. 1972[4]	117.9	4.49		4.21
Annual Avg. 1973[4]	125.9	4.82		4.48
Annual Avg. 1974[4]	153.8	5.43		4.85
Annual Avg. 1975[4]	171.5	6.13		5.37
Annual Avg. 1976[4]	182.3	6.75		5.89
Annual Avg. 1977	195.1	7.27	7.66	6.39
Annual Avg. 1978	209.4	8.26	8.56	7.01
Sept 1978	212.5	8.59	8.74	7.13
Oct 1978	214.7	8.64	8.83	7.19
Nov 1978	216.0	8.74	8.86	7.22
Dec 1978	217.2	8.76	8.97	7.28
Jan 1979	220.0	8.75	9.01	7.32
Feb 1979	222.5	8.85	9.02	7.32
Mar 1979	225.4	8.88	9.11	7.36
Apr 1979	229.0	9.07	9.49	7.50
May 1979	231.6	9.09	9.14	7.46
Jun 1979	234.0R	9.12	9.43	7.52
Jul 1979	237.5R	9.32	9.57	7.60
Aug 1979	240.3	9.38	9.70	7.65
Sept 1979	243.8	9.63	9.79	7.73
Oct 1979	248.5	9.70P	9.87P	7.81P
Nov 1979	250.2			7.87P

(1) Final revisions to 1977 data are as indicated. Producer Price Indexes are now routinely revised four months after they are first released to reflect the availability of late reports and corrections by respondents. Source: Bureau of Labor Statistics, *Producer Prices and Price Indexes*, Table 6. (Formerly *Wholesale Prices and Price Indexes)*

(2) Source: Bureau of Labor Statistics, *Employment and Earnings*, Table C-2.

(3) Monthly data for 1977 and 1978 appear in Report No. 125, dated December 31, 1978.

(4) Monthly data for these years appear in Section 10 of Report No. 107, dated June 30, 1977.
P = Preliminary
R = Revised

MARKET OPPORTUNITIES

Market Opportunities are *active* inquiries in the uranium market to buy, sell, borrow or lend. The data presented in this section are in no way intended to be indicative of the entire uranium market for the time period covered.

SUPPLY

Uranium Available for Sale

Delivery Year	Pounds U_3O_8 (1000's)	Nuexco Reference Number	Remarks
1980	650	1325	
	350	1270	
	100	1292	
	300	1333	
	600	1338	
	400	1274	
	350	1284	
	500	1324	
	500	1285	
1981	100	1306	
	300	1274	
	300	1286	
	500	1324	
1982	300	1274	
	200	1306	
	300	1286	
	200	1315	
1983	300	1286	
	200	1306	
	200	1315	

Uranium Available for Loan

Delivery Year	Return Year	Pounds U_3O_8 (1000's)	Nuexco Reference Number	Remarks
1980	1981	1000	1136	
	1982	725	1175	UF_6
	1983	1000	1196	
	1983	1000	1136	UF_6
	1983	1000	1239	UF_6
	1983	700	1234	

MARKET OPPORTUNITIES

DEMAND

Inquiries to Purchase Uranium

Delivery Year	Pounds U_3O_8 (1000's)	Nuexco Reference Number	Remarks
1980	500	1323	
	450	1337	
	1000	1334	
	500	1335	
1981	500	1228	
	250	1337	
	800	1260	
1982	300	1146	
	300	1227	
	250	1337	
	500	1228	
	400	1321	
1983	400	1321	
	250	1322	
	500	1228	

Inquiries to Borrow Uranium

Delivery Year	Return Year	Pounds U_3O_8 (1000's)	Nuexco Reference Number	Remarks
1980	1982	500	1121	
	1982	500	1135	
	1984	1000	1220	
	1983	1000	1240	

ANNUAL SUMMARY — 1979

REPORT HIGHLIGHTS OF 1979

January No. 126	Public & Gov't. Policy:	Chinese political philosophy vis à vis nuclear power
	General:	Premium price for 'stringless' uranium
	Australia:	Marketing of Ranger; softening of Labor Party opposition to uranium development; Koongarra EIS filed.
	Canada:	Favorable reports on exploration activity
	Central Africa:	CFA/US dollar uranium price relationships
	Europe:	Swiss opponents of nuclear power intensify campaign
	Japan:	Uranium procurement activities
	Southern Africa:	Floating Rand in South Africa; negotiations for Namibian independence
	United States:	Buying patterns; emergence of new producers
	Exchange Value:	Unchanged at $43.25; balance in current market; possible re-emergence of two-tiered price structure
	Raw Materials:	Elliot Lake District, Ontario
February No. 127	Public & Gov't. Policy:	Swiss anti-nuclear referendum defeated; several governments strengthen nuclear programs; anti-nuclear activism wanes in Australia
	General:	1978 contracts by US sellers
	Australia:	South Australian uranium policy; status of Ranger and Queensland
	Europe:	Swiss nuclear referendum narrowly defeated
	Japan:	Uranium procurement policy
	Southern Africa:	1978 uranium production in South Africa; Namibia update
	United States:	Market activity; uranium loans
	Exchange Value:	Unchanged at $43.25; discussion of two-tiered price structure
	Raw Materials:	Wyoming Tertiary Basins
Topical Report: March 19	Non-proliferation and the Uranium Market	
March No. 128	Public & Gov't. Policy:	Three Mile Island (TMI)
	General:	Nuexco estimates of world consumption of uranium
	Australia:	Market status of Ranger, Queensland and Western; deterioration of Labor Party opposition to uranium development
	Canada:	Exploration activity in the Northwest Territories
	Europe:	Badenwerk's KKP-1 achieved criticality; European dissatisfaction with US policy on uranium reprocessing and retransfer
	Japan:	Buying trends

ANNUAL SUMMARY — 1979

March (cont.)	Southern Africa:	Rossing mill repaired; new production centers in South Africa
	United States:	Interest shifts to post-1980 deliveries
	Exchange Value:	Unchanged at $43.25; declining constant dollar price of uranium
	Topical Essay:	Conflict in Nuclear Power Policy
	Raw Materials:	Uranium Deposits
April No. 129	Public & Gov't. Policy:	US Nuclear Regulatory Commission (NRC) response to TMI; international policy news
	Australia:	Marketing efforts accelerate; altered nature of marketplace
	Canada:	1978 exploration expenditures; potential for new discoveries
	Far East:	Status of nuclear power programs in Taiwan, Korea, the Philippines; Japanese buyers temporarily inactive
	United States:	High level of market activity, but few transactions close
	Exchange Value:	Unchanged at $43.25
	Raw Materials:	South Africa
Topical Report: May 8	Implications of the Three Mile Island Incident	
May No. 130	Public & Gov't. Policy:	USNRC imposes three-month moratorium on licensing; FRG postpones reprocessing indefinitely; damages awarded in Silkwood case
	Australia:	Australian government encounters difficulty in marketing its share of Ranger output; international safeguards agreements concluded
	Canada:	Export of uranium and nuclear technology
	Europe:	Market activity; buying patterns
	Japan:	Status of supply
	Southern Africa:	Two long-term contracts; diminishing premium for 'stringless' uranium
	United States:	Spot market quiet; effects of renegotiations and litigations
	Exchange Value:	Unchanged at $43.25
	Topical Essay:	Exchange Value and Transaction Value
	Raw Materials:	Geochemical Prospecting
Topical Report: June 15	World Uranium Resources	
June No. 131	Public & Gov't. Policy:	Strong EEC support for nuclear power
	General:	World market synopsis

June (cont.)	Australia:	Accelerating activity
	Canada:	Saskatchewan production
	France:	Uranium fuel cycle programs
	Japan:	Status of nuclear power program
	United States:	Market inactivity continues
	Exchange Value:	Edged downward to $43.00
	Raw Materials:	Overview of Uranium Reserves
July No. 132	Public & Gov't. Policy:	New US energy program announced
	General:	Revised Nuexco estimates of uranium consumption
	Australia:	Marketing efforts delayed
	Canada:	Westinghouse litigation development
	Japan:	Supply and demand
	Southern Africa:	Revised uranium resource estimates for South Africa
	United States:	Church Rock mill shutdown; effect of conversion contracts
	Exchange Value:	Decreased to $42.70; little near-term demand without concessions
	Topical Essay:	Uranium Loans
	Raw Materials:	Chattanooga Shale
August No. 133	Public & Gov't. Policy:	Former US Energy Secretary's view of US energy problem
	General:	Nuexco estimates of future US production
	Australia:	Queensland enters the market; government offers its share of Ranger; international safeguards agreements concluded
	Europe:	Market sluggish
	Japan:	Government pressures utilities to acquire equity in Ranger
	Southern Africa:	Political uncertainty in Namibia persists
	United States:	NRC, EPA disagree over mill tailings jurisdiction; production outlook clouded by declining ore grade; export transactions to date this year
	Pricing:	Exchange Value unchanged as gap grows between buyers' and sellers' perceptions of price; discussion of factors influencing Transaction Value; table of Transaction Values and associated factors
	Topical Essay:	The Uranium Industry in France and Germany
	Raw Materials:	Mexico Update
Topical Report: September 14	Uranium Supply and Demand in Japan	

ANNUAL SUMMARY — 1979

September No. 134	General:	Nuexco estimates of future world production
	Australia:	ACTU refused to endorse Ranger and Nabarlek
	Canada:	Staged development urged for Saskatchewan mines; Agnew Lake Mines announces planned closure of uranium operations
	Japan:	Inactivity continues
	Southern Africa:	New production records set at Rossing
	United States:	1979 DOE market price averages; federal judge refused to halt mining in the San Juan Basin
	Pricing:	Exchange Value fell $0.50 to $42.20
	Topical Essay:	Marketing and Procurement–Tools of the Trade I (bids, offers, inquiries)
	Raw Materials:	The Northern Colorado Plateau Uranium District
October No. 135	Public & Gov't. Policy:	Findings of US commission on TMI accident; antitrust litigation development in Britain
	General:	World Uranium Supply and Demand Balance
	Australia:	Status of marketing efforts
	Canada:	Saskatchewan exploration expenditures; government considers liquidating uranium stockpile
	Central Africa:	Rich deposit discovered in Asphalt district of Niger
	Europe:	Nuclear power stance of Swedish political parties
	Southern Africa:	Third quarter South African production up 12%
	United States:	Export-import balance; Nuexco concludes little likelihood of new US uranium export or import embargo
	Pricing:	Exchange Value unchanged at $42.20; sellers continue to resist price drop; buyers' market strength grows; present value concept removed from Transaction Value calculation; Transaction Value recomputed for past months
	Topical Essay:	Marketing and Procurement–Tools of the Trade II (brokers)
	Raw Materials:	Northeastern Washington Uranium District
November No. 136	General:	US Supply and Demand Balance
	Australia:	Ranger partners' sales to Korea; government's aggressive and coordinated marketing efforts reflect determination to acquire position in world market
	Canada:	Several transactions involving Canadian producers closed
	United States:	Imbalance in spot and near-term markets
	Pricing:	Exchange Value resumed decline, dropped $1.20; loan transaction closed

ANNUAL SUMMARY — 1979

November (cont.)	Topical Essay:	Spot and Other Markets (third in a series)
	Raw Materials:	By-product Uranium from Phosphate — Part I
December No. 137	Public & Gov't. Policy:	Effect of Middle East situation on energy programs and uranium demand; economic boom in South Africa and Australia; antitrust litigation development in Britain
	Australia:	Australian government sells its share of Ranger to Peko-Wallsend Ltd. — new company formed to handle the resulting 75% equity share
	Canada:	Saskatchewan to hold public hearings on uranium development in January 1980
	Japan:	Market activity; price negotiations; Japanese utilities to be involved in Peko-Wallsend's interest in Ranger
	United States:	IRS issued letter ruling concerning tax implications of uranium producers borrowing material for resale; mill tailings jurisdiction question resolved; New Mexico state legislature to consider an increase in the severance tax on uranium and other energy minerals during January 1980 session
	Pricing:	Exchange Value declined to $40.75; market outlook for producers; comparison of Exchange Value with what was shown to be an incentive price in 1960
	Topical Essay:	Uranium Prices & Price Mechanisms
	Raw Materials:	By-product Uranium from Phosphate — Part II
	Annual Summary:	Report Highlights of 1979

NUEXCO
NUCLEAR EXCHANGE CORPORATION

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EXECUTIVE SUMMARY & INDUSTRY OVERVIEW
NUEXCO REPORT NO. 137
Prepared Especially for Upper and Middle Management

Events in the Middle East may force the more industrialized nations to accelerate energy programs which reduce dependence on oil. While this is unlikely to cause a significant increase in short-term uranium demand, or in the number of *new* nuclear power plants ordered in the next few years, it might well help to slow, or even reverse, the growth of various barriers to nuclear power development.

The Australian government announced that it will sell its 50 percent share of Ranger to Peko-Wallsend Ltd. A new company, Energy Resources of Australia Ltd., will be formed to hold that share, plus the 25 percent interest now held by Peko in its joint venture with Electrolytic Zinc.

Public hearings on all facets of uranium development in Saskatchewan will be held in the province beginning in January 1980. Rulings are expected to favor continued uranium development.

Recent price negotiations and purchases demonstrate Japanese buyers' sensitivity to both the current uranium price decrease and the stronger position of buyers in the marketplace, and make them less likely candidates for additional purchases during the 1980's.

In January, the legislature of the state of New Mexico will consider an increase in the severance tax on uranium.

Exchange Value dropped $0.25 to $40.75 per pound U_3O_8, showing the additional pressure being exerted on prices by the presence in the market of inventory holders wishing to make spot sales. **Transaction Value** dropped substantially to $42.30 per pound U_3O_8 as older, higher-priced transactions dropped from the calculation sample.

This month's *Topical Essay* on uranium prices and price mechanisms is the fourth in a series on various aspects of the uranium market.

Raw Materials continues a discussion of by-product uranium from phosphate.

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NO. 138

JANUARY 31, 1980

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MONTHLY REPORT TO THE NUCLEAR INDUSTRY

No. 138 January 31, 1980

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THE URANIUM MARKET

PUBLIC AND GOVERNMENT POLICY 1.0
GENERAL
Conversion 1.0
Optimum Tails Assay 1.1
Government Statistics 1.2
AFRICA 1.4
AUSTRALIA 1.5
CANADA 1.6
EUROPE 1.6
JAPAN 1.6
UNITED STATES 1.6
PRICING 1.7

TOPICAL ESSAY

FORWARD COST 2.0

RAW MATERIALS

BY-PRODUCT URANIUM FROM PHOSPHATE—PART III 3.0

STATISTICAL DATA

EXCHANGE AND TRANSACTION VALUES 4.0
LOAN USE CHARGE RATE 4.3
CURRENT TRANSACTIONS 4.4
GOVERNMENT STATISTICS 4.5

MARKET OPPORTUNITIES

SUPPLY 5.0
Uranium Available for Sale
Uranium Available for Loan
DEMAND 5.2
Inquiries to Purchase Uranium
Inquiries to Borrow Uranium

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URANIUM MARKET

PUBLIC AND GOVERNMENT POLICY

In the **US**, the final report of the Committee on Nuclear and Alternative Energy has been issued by the prestigious National Academy of Sciences. The most important conclusion of the report, entitled *Energy in Transition, 1985-2010*, was that the only economically feasible sources of energy for the US for several decades will be nuclear fission and coal. However, the authors expressed two major concerns about the long-term use of coal for electric power. First, coal will be required for the production of synthetic fuels. Second, the environmental problems caused by burning coal, particularly the long-term atmospheric effects of CO_2, would be a limiting factor in coal utilization. Thus, the authors concluded that nuclear fuel should be favored over coal for the production of electricity. The preparation of the report received the financial support of the US Department of Energy (USDOE), and it has been officially transmitted to the Secretary of Energy. It is not known what part the report will play in the formulation of energy policy in the US.

The **USSR** continues to move ahead aggressively with nuclear power development. Comecen is striving to achieve a nuclear power generating capability of 150,000 MWe, or 25% of total capability, by 1990. Nuclear power now accounts for approximately four percent of electricity produced within the Comecen bloc.

Nuclear power has recently made progress in other countries. Orders for two new 500 MWe nuclear plants in **Japan** were announced this month. In **Italy**, a government committee studying nuclear power has published its conclusion that the country can safely proceed with its plan to build twelve additional nuclear plants. In **Spain**, an aggressive program has been announced in which the equivalent of $4.5 billion will be invested in electricity generating facilities employing coal, nuclear and hydropower. The program, which included three new nuclear power units, is aimed at reducing the nation's dependence on imported petroleum from the current 75 percent to 50 percent.

Recent polls indicated that **Sweden's** referendum to be held on March 23, 1980, may show the population strongly in favor of nuclear power. Rather than a constraint, the results of the referendum may prove to be a public mandate to proceed with the nuclear power program. There will be three options presented to the voters:

—Continue operating the six existing units, and proceed with the other six which are either under construction or on order.

—Continue operating the six existing units, and proceed with the other six, but phase out all nuclear power when the operating life of these twelve units is over.

—Operate only the six existing units, but phase them out between 1985 and 1990.

The Swedish government is providing funds to three different committees, one for each option, for public promotion. It is estimated that the third option will cost the Swedish economy about 100 billion Swedish kroner (about $24 billion) plus adverse secondary effects. Although under no obligation to do so, the coalition government has stated that it will accept the outcome of the referendum as binding.

Nuclear power accounted for 22 percent of Sweden's total electric power generation in 1979. The average capacity factor achieved by its six operating units in 1979 was 64 percent, with the Barseback 2 unit achieving a high of 80 percent.

In the **Federal Republic of Germany**, the ruling Social Democratic Party has approved Chancellor Schmidt's energy program, which placed primary emphasis on the building of more coal-fired power plants, with secondary emphasis on nuclear power. However, it is not likely that the FRG can increase its domestic coal production, presently 90,000,000 tons per year, before the late 1980's, if at all. Therefore, it is expected that, after the elections scheduled for the fall of 1980, the government will again support nuclear power as the first priority in meeting the nation's growing electric power demand.

GENERAL

Conversion

There are indications that a secondary market for uranium conversion services (uranium concentrates to UF_6) may be developing in North America. Recently, a transaction was completed for the secondary sale of a large quantity of conversion services. The contract was styled as a swap wherein UF_6 was exchanged for an equivalent amount of concentrates, plus a cash payment to cover the conversion cost. The cash payment amounted to approximately \$1.50 per pound U in UF_6, as compared to recent offers in the primary market well in excess of \$2.00 per pound U. Since other uranium market participants have indicated a desire to sell some surplus conversion services, this type of transaction might well be repeated.

The recent conversion transaction took the form of a swap, under which the following took place:

1. The seller of the conversion services (seller) instructed its conversion contractor (converter) to make UF_6 deliveries as required by the buyer of the conversion services (buyer).
2. The buyer delivered an equivalent amount of concentrates to the seller's account at a location specified by the seller.
3. After completion of the swap, the seller invoiced the buyer for the agreed conversion price.

Future transactions may take the same form as described above. From the standpoint of the seller of the conversion services, the transaction is in effect a "deconversion" of UF_6 (i.e. UF_6 to uranium concentrates).

An alternative form of reselling conversion services would be by partial or complete assignment of the conversion contract. However, this method normally requires the agreement of the converter since most conversion contracts contain provisions which allow assignment only with the consent of the other party. Such consent is by no means automatic.

Also, conversion contracts normally provide that while the customer's uranium is physically located at the conversion facility, the customer will retain title to it. The latter provision is normally thought to mean that, *as between the customer and the converter*, the customer would retain title, and the converter would retain mere possession. However, this provision has, in a number of cases, hindered the sale, swap, loan or other transfer of the uranium by the customer while the material was located at the conversion plant. This has made it difficult to transfer uranium located at a conversion facility without the converter's consent. Therefore, it may be easier for a seller in the secondary market to utilize the deconversion alternative rather than an assignment.

The deconversion transaction may involve some other problems. For example, if the UF_6 is to be delivered to the buyer at a location other than that specified in the seller's conversion contract (usually an enrichment facility), the converter may be unwilling to warrant quantities and specifications at the time the material is later delivered for enrichment. Also, the converter may not wish to commit UF_6 cylinders to long-term storage. Another potential problem arises if the concentrates which the buyer intends to transfer to the seller are already in the possession of the same or another converter.

If a market for deconversion develops, it will probably have many of the characteristics of a spot market for commodities, such as uranium. In any event, it seems likely to develop apart from what has been considered the conventional market for conversion services.

Use of the deconversion transaction would help to increase the fungibility of the industry's uranium inventory, which is principally located at the conversion facilities. More extensive use of commercial uranium storage facilities would also help in this regard.

Optimum Tails Assay

Included in the US Department of Energy (USDOE) Adjustable Fixed Commitment (AFC) enrichment contract are provisions allowing the customer to specify, within limits, the transaction tails assay. This "variable tails assay" option, combined with the weakening price of natural uranium and the escalating price of separative work, has sparked new interest in the determination of an optimum tails assay. The optimum tails assay is the tails composition at which the cost of enriched uranium is lowest for given costs of separative work and natural uranium feed. In fact, the optimum tails assay depends only on the *ratio* of the cost of a kilogram of natural uranium in the form of UF_6 to the cost of a kilogram unit of separative work (SWU). For a gaseous diffusion plant, there is an exact mathematical relationship:

$$\frac{C_f}{C_s} = (2X_f - 1)\log_e\left(\frac{X_f(1 - X_o)}{X_o(1 - X_f)}\right) + \frac{(X_f - X_o)(1 - 2X_o)}{X_o(1 - X_o)}$$

Where C_f is the cost of feed, C_s is the cost of a SWU, X_f is feed enrichment as a fraction, i.e. 0.00711, and X_o is the optimum tails assay as a fraction. The above relationship is plotted in Figure A. To use Figure A, it is necessary only to calculate the ratio C_f/C_s and find the corresponding optimum tails assay from the curve.

For example, the current price of a SWU under fixed commitment contracts is \$98.95. Using this month's Exchange Value of $40.00, and an estimated conversion price of $4.15/kg U (derived from USDOE's published prices for emergency feed) yields a feed price of $110.63. The ratio C_f/C_s is, therefore, 110.63/98.95, or 1.12. Using Figure A, the corresponding optimum tails assay is about 0.22 percent U_{235}.

Since AFC contract holders have this "variable tails assay" option, and since enriched uranium costs are lowest when the customer's transaction tails assay is optimum, many AFC holders may choose to exercise the option. Much of the natural uranium currently in inventory was purchased at prices below the current market price; thus, the optimum tails assay for enriched uranium produced from that material would be higher than 0.22 percent U_{235}. For example, the optimum tails assay calculated using the 1978 average uranium feed price reported by USDOE—$21.60 per pound U_3O_8—and today's SWU price—$98.95— is about 0.28 percent U_{235}.

Enrichment prices are escalating rapidly, while market prices for natural uranium have been declining. Thus, the optimum tails assay, about 0.22 percent U_{235} under current conditions, is expected to trend upwards. If AFC customers follow this trend and select higher transaction tails assays, the result will be an increase in natural uranium consumption over what it would have been at a tails assay of 0.20 percent U_{235}. The latter is the tails assay on which most consumption predictions, including Nuexco's estimates of Apparent Future Consumption, are based, and is also the transaction tails assay for Requirements Contracts. For every one-hundredth of a percentage point increase in the transaction tails assay, uranium consumption increases about two percent. Thus, increasing the transaction tails cent U_{235} would mean a uranium feed increase of four percent in order to produce the same amount of enriched uranium, and, consequently, the same amount of electrical output. A higher average transaction tails assay will, therefore, boost uranium requirements somewhat, mitigating some of the decrease in demand which has occurred over the past few years.

Government Statistics

Beginning in this issue, Nuexco will reprint selected government indexes for Australia and Canada. The data will appear in the *Statistical Data* section, following the US Government Statistics. In this Report only, a special supplement is included giving monthly listings for each of the indexes for recent years.

Nuexco's purpose in reprinting these statistics is to illustrate typical cost patterns for uranium producers in Australia and Canada. Although Nuexco believes that these statistics are representative of uranium industry cost history, their inclusion in this list should not be taken to imply their widespread use or approval for future use in Australian or Canadian uranium sales agreements. Also, since errors in reprinting may occur, persons using these indexes for administering uranium sales agreements should make arrangements to obtain the data directly from the appropriate government sources. Nuexco would be happy to assist any Subscriber in obtaining the appropriate publications.

The remainder of this section presents a summary of the explanatory notes relevant to each of the indexes to be reprinted.

Australia—Price Index

1. The index is the "Price Index of Materials Used in Manufacturing Industry—All Groups." It measures changes in prices of materials and fuels used in manufacturing. It does not reflect changes in other important costs such as labor and capital inputs to manufacturing, and taxes incurred during manufacturing.

2. These data are reprinted from Table 3 of "Price Index of Materials Used in Manufacturing Industry," a monthly publication of the Australian Bureau of Statistics, catalogue number 6411.0.

3. The index relates only to materials used within the Manufacturing Division of the Australian Standard Industrial Classification and which have been produced outside that Division. The pricing and weights for the index reflect usage of materials at the point of entry to the Manufacturing Division.

4. Index numbers for the two most recent months are preliminary and may be revised. Figures for earlier months are generally not revised. Index numbers for financial years are simple averages of monthly index numbers.

Australia—Wage Rates

1. The index is "Weekly Wage Rates—Adult

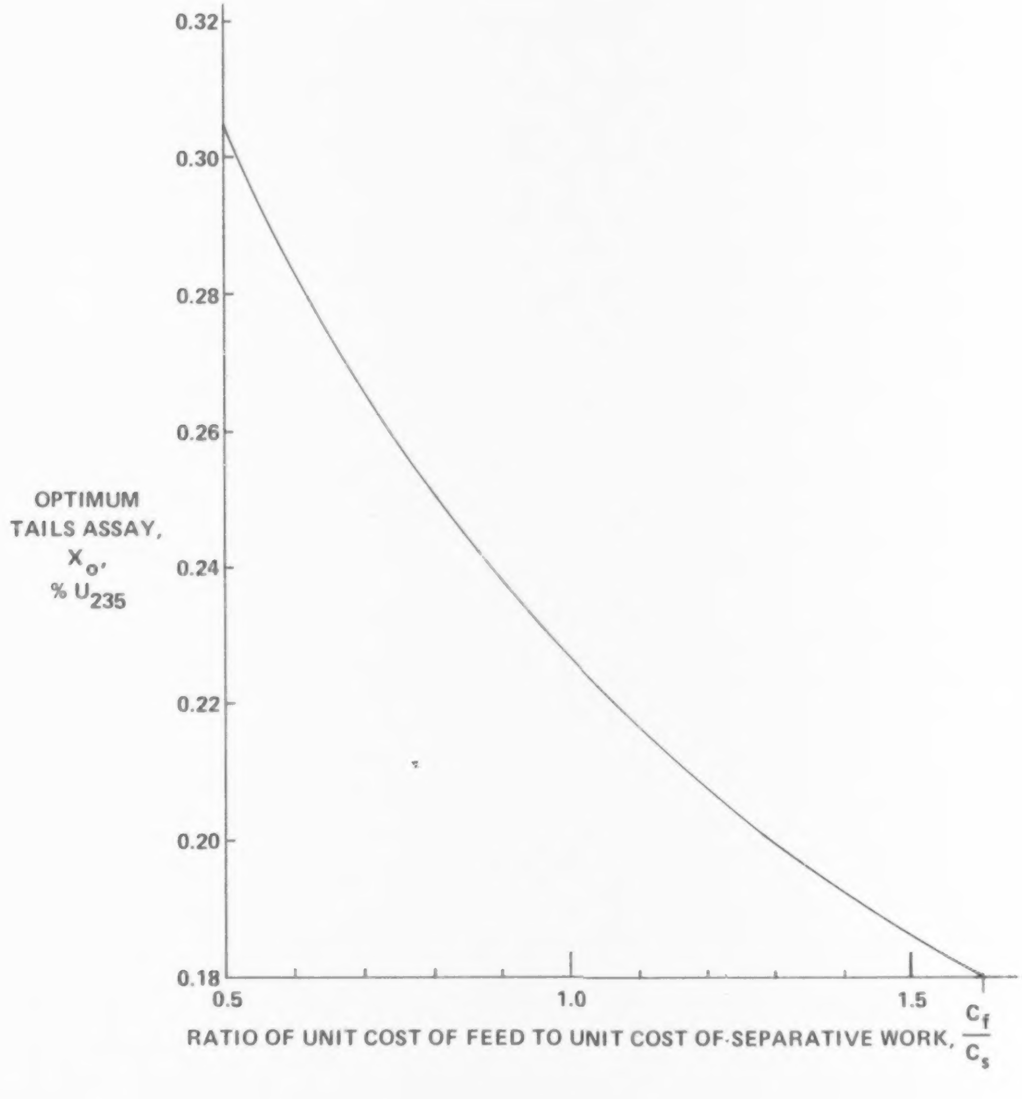

Figure A
TAILS ASSAY FOR MINIMUM COST OF PRODUCT

Males, Mining and Quarrying, Australia." The wage rates used are the minimum rates for a full week's work (excluding overtime). In most cases, the rates are as prescribed in awards or determinations of Federal or State industrial authorities, or in collective agreements registered with them. Rates prescribed in unregistered collective agreements are used where these are dominant in the particular industries to which they refer.

2. These data are reprinted from Table 1 of "Wage Rates, Australia," a monthly publication of the Australian Bureau of Statistics, catalogue number 6312.0.

3. Payments which do not apply to all workers in a particular occupation (for example, those payable for working in wet, dirty, confined or isolated places) are not included in the wage rate data. From September 1978, the statistics include supplementary payments under the Metal Industry Award, Part 1, applicable in all states except Western Australia. In Western Australia, similar payments under the corresponding award, the Western Australian Metal Trades Award (General), have been included since January 1976.

The statistics are designed to measure trends in wage rates in current awards, etc. excluding the effects of changes in the relative importance of industries, awards and occupations. The weighted average wage rates are, therefore, indexes expressed in monetary terms, and do not purport to be actual current averages.

4. Data for the latest twelve months shown are subject to revision. As such revisions are made and published, they will be reprinted in the *Statistical Data* section of the Nuexco Monthly Report.

Canada—Price Index

1. The index is "Industry Selling Price Index: Manufacturing (D500000)." The data are reprinted from Table 1 of "Industry Price Indexes" a monthly publication of Statistics Canada, Prices Division.

2. Figures for the most recent six months shown are subject to revision. As such revisions are made and published, they will be reprinted in the next Nuexco Monthly Report.

3. The index measures pure price changes of specified commodities having a base of 1971 = 100.

4. The initial selections of responding firms and of commodities to be priced are based on a series of annual surveys collecting data on shipments of commodities, employment and materials used. Prices are f.o.b. factory gate, less discounts and before taxes. Prices are collected for new orders placed on the 15th of each month or the nearest transaction data for the commodity being priced.

5. The index is gross-weighted. It measures the movements of prices of gross shipments of manufacturing industries, including inter-industry shipments between individual industries within manufacturing. There, the movements of some prices are duplicated.

Canada—Wage Rates

1. The index is "Wage-earner Data: Average Hourly Earnings," for three SIC (Standard Industrial Classification) codes:
   a. SIC 050-059; Metal Mining, Including Milling;
   b. SIC 296-298; Primary Metal Industries, Non-ferrous;
   c. SIC 370-379; Chemicals and Chemical Products

2. The data are reprinted from Table 2 of "Employment, Earnings and Hours," a monthly publication of Statistics Canada, Labour Division, Employment and Payrolls Section.

3. Wage-earners are employees engaged in actual production and related operations including support personnel and working foremen performing functions similar to those of the employees whom they supervise. Average hourly earnings data are computed only for those wage-earners for whom hourly details are reported.

4. Earnings represent gross pay for the week, before deductions for taxes and unemployment insurance contributions. Gross pay includes salaries, straight time wages, piece-work and regular commission earnings, regular paid incentive, cost of living and other bonuses, overtime earnings and payments to persons absent with pay in the survey reference week.

AFRICA

Calendar year 1979 uranium production in the **Republic of South Africa** is as follows:

	Thousands of Pounds U_3O_8
Blyvooruitzicht	631
Buffelsfontein	1,367
ERGO	527
Harmony	1,193
Hartebeestfontein	868
JMS	1,534
Palaborwa	284
Randfontein	919
Stilfontein	533
Vaal Reefs	2,806
West Driefontein	635
Western Deep Levels	439
West Rand Consolidated	811
TOTAL	12,547

The total is a 22 percent increase over the 10,268,000 pounds U_3O_8 produced in 1978. The increase is largely due to the buildup of production at Randfontein and the start-up during the year of the Vaal Reefs South Vaal plant and Stilfontein's Chemwes plant. South African production will continue to increase over the next few years. Additional capacity is due on stream in 1980 at Harmony, Western Deep Levels and JMS. Uranium production is expected at Afrikander Lease in 1981, and at Beisa in 1982. In addition, it was announced this month that uranium will be produced at the Western Areas gold mine. Development of a new section containing ore high in uranium has begun, and it is expected that uranium production will commence in 1983.

With the recent astronomical rise in the price of gold, it is possible that uranium production in South Africa could be increased even further. Higher gold prices mean that more gold-bearing areas would become economically exploitable. Also, new tailings recovery operations might come under consideration. Both occurrences could lead to an increase in uranium production. On the other hand, however, most gold mines have dropped cutoff grade when gold prices increased in the past. Since gold and uranium grades tend to go together, a drop in average grade might somewhat reduce uranium production in existing mines. In fact, uranium production in three mines dropped in 1979 due to falling grade. However, if current gold price levels continue, the strong incentive for new production units will probably overshadow any production decreases due to grade reduction.

AUSTRALIA

Electrolytic Zinc (EZ) has decided to join Peko Wallsend in its purchase of the government's 50 percent share of Ranger. EZ will, like Peko, transfer its 25 percent interest in Ranger to Energy Resources of Australia (ERA), which will then hold all of the equity in Ranger. The EZ decision will probably necessitate some changes in the percentage ownerships of the various entities. Peko and EZ will be the largest shareholders, presumably, owning about 30 percent each. If 25 percent were then sold to non-Australian entities, 15 percent would be left for a public share offering in Australia.

As previously reported, Japanese, German and British interests are viewed as the most likely non-Australian equity holders. Japan's interest will be represented by several utility companies; their situation is discussed in the **Japan** section of this Report. The German interest will probably be held by Urangesellschaft and Saarberg Interplan, neither of which is an end-user, while British interests will probably be represented by the British Civil Uranium Procurement Organization.

Perhaps of greater interest to buyers than the ownership breakdown is how the material will be marketed. While many details remain to be worked out, several points are already clear. Contracts to purchase Ranger output will be between ERA and end users. Thus, the non-Australian equity holders that are end users will contract with ERA. Further, non-Australian equity holders that are not end-users must, as a precondition to such equity participation, arrange for end-users to enter into sales contracts with ERA.

It seems certain that Ranger Export Development Company (REDCO) will continue to market the Ranger production associated with the Peko and EZ interests, and it would also be logical for it to market the balance of the Australian share. At the same time, other companies have begun discussions with utility buyers regarding the Ranger production, in connection with the purchase of equity in ERA.

This has led to some confusion among buyers as to who is authorized to offer what. This confusion is a natural consequence not only of the uncertainties surrounding the formation of ERA, but also of the attempts by the various participants and would-be participants to establish or improve their positions in the new organization. As the structure of ERA is finalized, it is to be expected that the responsibility and authority of the parties will be better defined.

This situation notwithstanding, a letter of intent has been signed by a US utility for long-term supply from Ranger.

CANADA

In accordance with the provincial Public Inquiries Act of January 1979, British Columbia has appointed a commission to hold public hearings on all aspects of uranium mining within the province. The commission held an initial series of community hearings and technical hearings in 1979 on exploration, mining, milling, waste management and environmental impact of uranium mining. Further technical hearings are being held during 1980 in Vancouver from January through June, with additional community hearings scheduled for September to November.

The commission will require about a year to prepare a report on its findings. There is currently no uranium mining in British Columbia; however, mining of the Blizzard uranium reserves, for which a sales contract was recently signed, is subject to approval of the provincial government.

EUROPE

If renegotiation of the US/Euratom agreement for cooperation has not been completed by the March 10, 1980, deadline as set forth in the US Nuclear Non-proliferation Act of 1978, it could mean that US exports to the Euratom nations after that date would be discontinued. However, under the Act, the US President has the power to order a twelve-month extension of the deadline (which can then be extended annually for a further twelve-month period) if he feels that failure to continue cooperation with the Euratom nations "would be seriously predjudicial to the achievement of United States non-proliferation objectives or otherwise jeopardize the common defense and security," and if he notifies Congress of his intention to extend the time. The US State Department has already recommended that President Carter order the twelve-month extension, and he is expected to follow the recommendation.

JAPAN

It seems almost certain that Japanese utilities will take up approximately ten percent of the equity of Energy Resources of Australia (ERA), the new corporation that will own Ranger. The Japanese utility participants will include Shikoku, Kyushu and Kansai, although Chubu may also participate. Conspicuous by its absence is Tokyo Electric Power Company (TEPCO), Japan's largest utility, which has shown no interest, presumably because it will have a uranium inventory of nearly 10,000,000 pounds U_3O_8 during the 1980's.

While a ten percent equity position in ERA translates into only about 650,000 pounds U_3O_8 annually, such participation would place the Japanese in a favored position to purchase additional material under conventional contracts. However, Japanese participation in this project has, from the outset, been marked by a curious lack of enthusiasm. This suggests:

—That their participation is based more on the importance of general Australian-Japanese trade relations than on any great need for uranium in the 1980's.

—Recognition of the fact that Japan has already contracted for substantial tonnage from Australia, not only from Ranger, but also from Queensland Mines and Mary Kathleen.

—Recognition that, in the aggregate, Japan's existing and projected inventory is already extremely large, and growing.

It can be concluded that, in the near term, Japanese buyers will be increasingly selective in their procurement, particularly if prices continue to be weak.

UNITED STATES

This month, two tentative settlements in the series of utility lawsuits with Westinghouse Electric Corporation were announced, leaving only two of the original 17 lawsuits unresolved. As in previous settlements, Westinghouse will deliver some uranium as well as provide cash, equipment and services. The settlements thus far account for about 85 percent of the uranium originally involved in the litigation, some 65,000,000 pounds U_3O_8.

Six US nuclear power units were officially canceled this month. The Central Area Power Coordinating Group (CAPCO) announced the cancellation of Eire 1 & 2, and Davis-Besse 2 & 3. Long Island Lighting Company announced the cancellation of Jamesport 1 & 2. Regulatory problems were cited as primary reasons for all six cancellations.

The near-term market in the US was active this month. Leading the activity was the inquiry from the Federal Republic of Germany to purchase 1,000,000 pounds U_3O_8 for 1980 delivery, in connection with the offset agreement between the US and the FRG. The due date for offers was January 25, and response to the invitation was enthusiastic. The total quantity of material offered by US sellers amounted to about 6,000,000 pounds U_3O_8, or six times the amount of the inquiry. The German government will decide during February which offers to select.

This request for offers was sent to virtually every uranium producer and nuclear utility in the US. Of the responses received, most were from inventory holders. The large quantity of material offered indicates that there is more material available for sale in the US market than is being actively offered at this time. This widely publicized request for offers may have caused a few utilities to revaluate their inventory positions to make material available for sale. The offers were generally made at fixed prices, most being below last month's Exchange Value.

Besides the German offset, there is additional active demand in the US market, and more appears to be forming. A few utilities have been attracted into the near-term market by declining prices, and they may purchase small amounts of material. Also, declining ore grade and rising production costs, combined with lower prices, may put some US suppliers in the position of making spot purchases of material to deliver under current contracts, in lieu of producing the material themselves.

PRICING

The **Exchange Value** decreased again this month to $40.00 per pound U_3O_8, a decline of $0.75. Utility inventory sellers have been, and continue to be, a significant factor in the price decline. With its regulatory and tax implications, the decision to sell inventory is both difficult and unusual for utilities. Once the decision is made, however, disposal of the material tends to take priority over price.

Thus, the active price competition in the current market is primarily among inventory sellers. Uranium producers themselves have not been as active for the following reasons:

—Producer resistance has hardened as the market approached the $40.00 level.

—Due to falling grade, there is little excess production available to sell on the spot market.

—Some producers with adequate cash flow have indicated their determination to hold excess production off the market if they consider prices too low.

—Finally, some higher-cost producers are considering the economic benefits of purchasing, rather than producing, the concentrates needed to fulfill delivery obligations.

This situation suggests that producers will probably make few sales in the spot and near-term markets, until such time as the redistribution of inventory has been completed and new demand is placed on conventional supply sources.

A weakening price structure is also likely to impede intermediate and longer-term contracting. Producers will be more reluctant than ever to contract without some type of floor-price mechanism. The same price weakness raises concern among utilities that formula prices, if not well below present market levels, may exceed market by the time of delivery. Such a price spread is becoming increasingly difficult to attain, because costs are rising and prices are declining.

The **Transaction Value** also decreased this month to $42.00 per pound U_3O_8 as new, lower-priced transactions were added to the sample. The **Loan Use Charge Rate** remained at seven percent per annum. Uranium available for loan has increased dramatically in recent months (see *Market Opportunities)*. Although no loans closed this month, several are in serious negotiation, and the rates being discussed are generally around the seven percent level.

TOPICAL ESSAY

FORWARD COST

Introduction

As used in the computation of uranium reserves, the term *forward cost* has been subject to misunderstanding and misuse. This discussion is intended to help clarify what the term means and, equally important, what it does not mean.

In calculating ore reserves* in a given cost category, the US Department of Energy (USDOE) defines forward cost as all capital and operating expenditures incurred after the date of the ore reserve estimate, in building, maintaining and operating new and existing uranium mine and mill facilities.

Analyses of reserves based on forward cost are primarily useful for estimating the long-range sufficiency of uranium, and for estimating the economic competitiveness of domestic reserves versus potential foreign supplies. The information can be used to formulate government and industry strategy on uranium supply, to develop long-range exploration planning by the uranium industry, and to aid utilities in planning long-term uranium supply strategies and evaluating fuel supply for future power generation alternatives.

Forward Cost vs. Price

The forward cost associated with a uranium reserve must not be confused with the price at which production from that reserve could be sold on an economical basis. The most important consideration in reserve assessments made by USDOE is whether or not a given reserve can be produced within a certain unit cost range (i.e. meet direct and indirect operating costs, and recover forward capital costs for each unit produced). The considerations of the owner of the reserve are usually quite different. The owner will consider the reserve economically exploitable only if its production can be sold at a price which will not only cover the forward costs, but also capital already spent, and earn an acceptable return on investment commensurate with the risks involved.

Factors Included in Forward Cost Estimates

The factors included in USDOE forward cost estimates are tabulated in Table A. The forward cost basis for classification of reserves is practical from USDOE's standpoint, since it does not require complete data regarding the timing and magnitude of past expenditures by the operating companies—data which are sometimes difficult to obtain. Also, information is not required on the operating companies' opportunities for alternate investments, policies on rate of return on investments, tax considerations, interest costs, etc.

Forward cost estimates include only expenditures yet to be made for direct and indirect capital and operating costs at the time of the estimate. To better understand what is excluded, it is instructive to examine the definition carefully.

Funds already spent, i.e. *sunk costs*, are not included in forward cost estimates. Usually, substantial capital costs have been incurred prior to establishing a reserve to the point where a determination can be made to proceed with development. Therefore, for USDOE reserve analyses, the total cost of land acquisition and exploration and development drilling are not included in the forward cost estimates. Also, for reserves associated with production facilities currently in operation or under construction, all, or nearly all, of the project capital will have been invested already, and will not be included as a forward cost.

Inflation is also excluded, even though forward costs are future expenditures. Of course, inflation is taken into account as forward cost estimates are periodically updated. Over the years, this effect usually leads to erosion of reserves in the lower forward cost categories.

Only direct and indirect operating and capital expenditures are considered. Since USDOE is not in a position to assess the cost of money and tax situation for the individual operating companies, these factors are left out of the calculation entirely. Thus, *return on investment* (profit or earnings), *interest* on debt, and federal and state *income taxes* are not included in the estimates. Forward costs associated with environmental regulations are included to the extent that they are known at the time the estimate is performed. That is, only environmental requirements as of the date of the estimate are included.

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*The term *reserves,* as used by USDOE, is roughly synonymous with the term *reasonably assured resources* used by the International Atomic Energy Agency. The two are often used interchangeably.

TOPICAL ESSAY

Table A
COST ELEMENTS OF USDOE URANIUM ORE RESERVES ESTIMATES

Category	Cost	Description of Cost Element
Capital Costs (Applied only on a forward-cost basis)	Acquisition	Includes cash purchase, stock transfer, concession, lease or claim location. Acquisition costs for properties acquired prior to current evaluation are not considered.
	Surface Exploratory Drilling	Drilling carried out to discover ore in favorable areas (consists of widely-spaced drill holes).
	Surface Developmental Drilling	Drilling carried out to define U_3O_8 grade distribution (consists of closely-spaced drill holes).
	Mine Surface Plants	Surface installations and associated equipment, including hoists, headframes, shops, shop equipment and grade control stations.
	Mine Equipment	All underground or open-pit mining equipment required to extract ore from a deposit.
	Mill Construction	Includes site preparation, material, labor, supervision, engineering and equipment involved in constructing a processing plant.
	Primary Development	All operations involved in developing an orebody preparatory to actual mining. Includes shaft-sinking, stations, pumping levels, haulage drifts, raises, inclines, ventilation shafts, emergency exits and long-hole drilling for underground mines, and overburden-stripping and ramp construction for open-pit mines. Also includes a proportionate share of general and administrative expenses.
Operating Costs	Mining Operations	All direct and indirect costs involved in extracting ore from a deposit after access has been made to its underground location. Included are costs for supervision, engineering, power, materials, labor, payroll taxes and land reclamation. Also included are costs for production taxes imposed by states and counties, property taxes, insurance, and a proportionate share of general and administrative expenses.
	Haulage	Cost of loading and transporting ore from mine site to mill.
	Royalty	Payments to landowners or controllers, usually as a percentage of the gross value of ore delivered to the mill.

TOPICAL ESSAY

Likewise, only severance taxes in existence at the time of the estimate are included.

Return on Investment

The uranium industry is capital-intensive. Large amounts of money must be spent over a long period of time before a project has been completed and begins to yield a return on the investment (ROI). Also, like most mineral industries, uranium development is viewed as relatively risky, and a high expected ROI is normally required for a uranium project to be developed. In such a capital-intensive project, where money is spent well in advance of earnings, ROI and associated taxes will normally represent a substantial part of the selling price. While difficult to quantify, a rule of thumb for conventional uranium projects exists: if an after-tax, discounted cash flow ROI of fifteen percent is desired, then for every dollar of capital investment, it is necessary to generate five to seven dollars of gross revenue in order to recover ROI, interest, income taxes and capital. This assumes that the percentage depletion allowance for uranium currently available in the US remains in effect. The characteristics of the individual project and the financial and tax status of the operating company will determine where, within this range, each situation falls.

A question often asked when forward cost is discussed is whether there is a factor which, when multiplied by the USDOE forward cost estimate for a reserve, would yield the selling price necessary to make the reserve viable. A general rule of thumb in this regard can be stated; however, in so doing, it is important to note that reserves are usually classified in specific forward cost categories characterized by upper cutoff costs. The average forward cost of reserve units contained within any given cost category will be less than the upper cost cutoff. The upper cost cutoff is the cost at which all reserves in that cost category could be recovered, but each category contains a distribution of costs for reserves within that category.

Nuexco estimates that the approximate ratio of selling price to forward cost for a typical reserve recoverable by conventional methods is in the range of 1.5 to 1.75 for a 15 percent after-tax discounted cash flow return on investment. For a 20 percent return on investment, the ratio would be in the range of 1.7 to 2.0. The characteristics of the individual project and the financial and tax status of the operating company will determine where each particular reserve unit falls.

Conclusion

Forward cost is clearly defined for purposes of estimating reserves. For various reasons, forward cost estimates are often used by industry participants to draw inferences regarding future prices. Several important cost factors are omitted from forward cost estimates, so care should be taken in making any such inferences.

The most important items excluded from forward cost estimates are: sunk costs (especially for production centers operating or under construction), return on investment, interest, and federal and state income taxes.

Due to these exclusions, there will generally be a substantial gap between the estimated forward cost of an ore reserve, and the selling price needed to develop it viably.

BY-PRODUCT URANIUM FROM PHOSPHATE—PART III

Uranium Recovery Technology

A process for extracting uranium from phosphoric acid was first developed during an intensive research and development (R&D) program sponsored by the US Atomic Energy Commission (USAEC) in 1947. Four US producers of phosphoric acid participated in the program and were instrumental in developing a recovery process which became known as the Pyro solvent extraction process, or the OPPA process.[1] Three of the four companies recovered uranium on a limited basis at their respective phosphoric acid plants, producing approximately 1,000,000 pounds U_3O_8 during the period 1954 to 1962. At that point, uranium production from phosphoric acid became noncompetitive with increasing output from uranium mines in Wyoming and New Mexico, and, consequently, came to an end.

At the Oak Ridge National Laboratory in Tennessee, recovery R&D continued throughout the 1960's and early 1970's, resulting in the development of two additional recovery processes utilizing improved solvents and new technology. The DEPA-TOPO process was developed in the late 1960's, and the OPAP process around 1974.[2] All three of the processes are presently used in recovering uranium from phosphoric acid.

Interest in the recovery of uranium as a by-product of phosphoric acid production was renewed by private industry in the late 1960's. The three processes are basically the same recovery methods used today; the principal difference among them is the pre-treatment of the acid stream. Florida phosphorites contain about one percent organic materials, and their removal from the acid stream is essential to economical uranium recovery.[3] This stage in the process is usually regarded as proprietary, and the technology and application vary among producers.

Recovery Activity in the US and Canada

In 1975, UNC Recovery Corporation constructed the first new generation uranium recovery plant at the phosphoric acid facility of W. R. Grace & Company near Bartow, Florida, following six to eight capacity of 330,000 pounds U_3O_8 per year.[4] The recovery process closely parallels the two-stage OPAP process—organic washing, solvent extraction, and stripping of uranium from the solvent is completed at the site of the phosphoric acid plant; the pregnant solution is then trucked to a central processing plant for purification and U_3O_8 concentration. UNC Recovery Corporation has the option to build a second production center with a capacity of 440,000 pounds U_3O_8 per year.

Wyoming Mineral Corporation (WMC), a wholly-owned subsidiary of Westinghouse Electric Corporation, initiated R&D for the recovery of by-product uranium in 1970, working jointly in 1972 with Gardinier, Inc., of Tampa, Florida. Later, WMC contracted to recover uranium from the Farmland Industries, Inc., phosphoric acid facility at Pierce, Florida. WMC designed and built a uranium recovery plant with an annual capacity of 400,000 pounds U_3O_8. The plant began operating in late 1978, and presently functions near capacity. Farmland is the operator, but all production goes to WMC. WMC contemplates eventual participation in additional recovery projects with phosphoric acid producers in other countries. Following pre-treatment of the acid stream, WMC uses what is basically the DEPA-TOPO process to recover U_3O_8.

Freeport Uranium Recovery Company, a subsid-

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[1] The fundamental process consists of reduction of uranium contained in phosphoric acid by the addition of iron; solvent extraction utilizing octyl pyrophosphoric acid diluted with kerosene; clarification of the loaded solvent; stripping/precipitation and purification; and drying of the uranium.

[2] The two-stage DEPA-TOPO process uses a solvent mixture of di(2-ethylhexyl) phosphoric acid and trioctyl phosphine oxide to extract, concentrate and purify the uranium. The OPAP process uses the solvent octylphenyl acid phosphate to concentrate the uranium in the first stage of the process. The uranium is extracted and purified with DEPA-TOPO solvent in the second stage.

[3] Uranium cannot be economically recovered from phosphoric acid containing organic material, which is dark in color and is referred to as "black" or "brown" acid. The acid must be cleaned by removing the organic material. It is then referred to as "green" acid. Uranium is more readily recovered from the "green" acid.

[4] Production capacity for all uranium plants is based on phosphoric acid production. Actual uranium content of phosphate rock commonly varies within the deposit and from deposit to deposit. Uranium production therefore varies and capacities herein referred to are approximate.

RAW MATERIALS

iary of Freeport Minerals Company, has constructed a recovery plant at its phosphoric acid facilities near Uncle Sam, Louisiana. Although Freeport's pre-treatment technology is proprietary, the basic recovery method is the DEPA-TOPO process. Plant start-up was early in 1979, and production exceeded 600,000 pounds U_3O_8 for that year, making it the most successful operation to date. Design capacity is 690,000 pounds U_3O_8 per year. It is anticipated that design capacity will be achieved during 1980, the first full year of operation. Freeport has arranged long-term sales contracts for the output of this plant.

Freeport is financing the construction of an additional recovery plant under an agreement with the Agrico Chemical Company in connection with its phosphoric acid operation near Donaldsonville, Louisiana. The new plant is scheduled for start-up about mid-1980 and will have a design capacity of 420,000 pounds U_3O_8 per year. Freeport is to be the operator of the recovery plant, and will receive all uranium concentrate produced. Freeport has arranged long-term sales contracts for all uranium production from this plant.

Gardinier, Inc., assumed full operating responsibility for its uranium recovery plant in East Tampa, Florida, as of June 1979. The plant has a design capacity of 425,000 pounds U_3O_8 equivalent per year. Plant output will actually be in the form of UF_4. The production rate is presently approaching design capacity. The uranium is recovered by a modified, technically improved OPPA process. Gardinier is the only company currently producing UF_4. It has arranged a long-term sales contract for the output of this plant.

International Minerals & Chemical Corporation (IMC) has been involved in the recovery of by-product uranium since participating in the USAEC R&D program in the 1950's. After years of additional work, IMC built a pilot plant adjacent to its new phosphoric acid facilities at New Wales, Florida, in 1977, and started construction of the world's largest plant for by-product uranium recovery at the same site in 1978. This plant is scheduled for completion in March 1980. Its design capacity is 800,000 pounds U_3O_8 per year, and IMC expects to be in full production by late 1980.

IMC will construct additional recovery units at the two acid plants owned by CF Industries, one located in Bartow, and the other at Plant City, Florida. Both recovery units are scheduled for completion by early 1981. Combined design capacity will be 1,200,000 pounds U_3O_8 annually. The product from each primary unit will be transported to the main recovery facility at New Wales for final processing. IMC will operate both plants and receive all uranium concentrate production.

IMC uses the basic DEPA-TOPO process, with one significant variation. Activated carbon is used to remove organic material from the acid stream. Second-phase treatment requires the application of an organic solvent, which extracts uranium from the phosphoric acid. The uranium is then separated from the solvent for final extraction and purification. IMC expects that extraction efficiency will be about 90 percent. IMC has arranged long-term sales contracts for all uranium concentrate recovered in these plants.

There is only one uranium-from-phosphate recovery operation in North America outside Florida and Louisiana. Earth Sciences, Inc. (ESI), of Golden, Colorado, and Western Cooperative Fertilizers Ltd. (WCFL) of Calgary, Alberta, have entered into an agreement under which the ESI group financed and constructed a plant to recover uranium from the WCFL phosphoric acid facility at Calgary. The plant is in the last stages of construction, with start-up scheduled for February or March 1980. Annual design capacity is 120,000 pounds U_3O_8. ESI will operate the plant and take delivery of all uranium produced. It has an option to build a second recovery unit of about the same size for the WCFL phosphoric acid plant at Medicine Hat, Alberta. Construcion is tentatively scheduled to begin in early 1981.

The phosphate ore for the WCFL plant is mined by open pit methods from a mine near Conda, Idaho, and transported by rail to the phosphoric acid plant at Calgary. The uranium recovery process used is a modification of the OPAP process. The solution is reduced rather than oxidized, followed by final-stage solvent extraction and purification.

Two additional producers of phosphoric acid in Idaho are considering the recovery of uranium. The J. R. Simplot Company recenlty completed a successful pilot test for uranium recovery at its Don phosphoric acid plant in Pocatello. The company announced in December that construction of a commercial recovery plant at the Don site would begin about mid-1980. The design capacity will be 120,000 pounds U_3O_8 per year. The basic recovery method used will be the DEPA-TOPO process, modified to accommodate phosphoric acid made from calcined phosphate rock.[5] An important difference between the J. R. Simplot recovery process and the processes in use elsewhere is that the end product at the Don facility will be a high-grade uranium slurry. In addition, the process includes the recovery of vanadium, which averages about 2.5 pounds V_2O_5 per ton of phosphoric acid. The vanadium will be recovered in solution form for processing later.

Becker Industries Corporation recently announced its intent to construct a pilot plant for uranium recovery at its phosphoric acid facility near Conda, Idaho. The pilot plant will be financed by Mono Power Company, a subsidiary of the Southern California Edison Company. If the pilot project is successful, the companies which will have an annual capacity of 200,000 pounds U_3O_8. The recovery of by-product vanadium will also be considered. Construction of the pilot plant is scheduled to begin in mid-1980.

Table B is a summary of projects involving uranium recovery from phosphoric acid. Plant capacities are approximate. The uranium contained in an acid stream is subject to variations in plant feed quality and quantity (cf. footnote 4 above). The amount of uranium recovered from the acid stream will vary from about 75 to 90 percent, depending upon the efficiency of the recovery technique; however, annual uranium production from phosphoric acid could, under ideal operating circumstances, total about 4,400,000 pounds U_3O_8 by the end of 1981, and about 4,800,000 pounds by 1983.

Summary

The recovery of uranium from phosphoric acid is not a new idea—it is a rejuvenated one, brought to life again by the development of new recovery technology at a time when the demand for, and value of, uranium concentrates were steadily increasing. As a show of confidence in the new technology and the uranium market, six companies in North America will have invested well over $220,000,000 by the end of 1980 in uranium recovery from phosphates.

In general, the US phosphate industry has the capacity of rapidly expanding uranium recovery well beyond the present level on the basis of in-place phosphoric acid production capacity. The greatest potential for expansion is in the central Florida district, where the amount of uranium contained in the rock, as well as wet-process phosphoric acid production, is highest. The growth potential for uranium production from western phosphoric acid will be minor, compared to that of the Florida operations. However, it is doubtful that overall recovery capacity will continue to expand, due to the declining price of uranium.

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[5] Western phosphorites contain about 4 percent organic material which is recovered during a calcining process prior to the production of green acid.

RAW MATERIALS

Table B
SUMMARY OF OPERATIONS FOR RECOVERY OF URANIUM FROM PHOSPHORIC ACID

Company	Plant Location	Design Capacity Pounds U_3O_8/yr.	Status
Facilities Operating or Under Construction			
UNC Recovery Corporation at W.R. Grace & Co.	Bartow, Florida	330,000	Operational
Wyoming Mineral Corporation at Farmland Industries	Pierce, Florida	400,000	Operational
Freeport Uranium Recovery Co.	Uncle Sam, Louisiana	690,000	Operational
Freeport plant at Agrico Chemical Co.	Donaldsonville, Louisiana	420,000	Start-up mid-1980
Gardinier, Inc.	Tampa, Florida	425,000	Operational
International Minerals & Chemical Corporation	New Wales, Florida	800,000	Start-up March 1980
IMC plant at C.F. Industries, Inc.	Plant City, Florida	600,000	Start-up by early 1981
IMC Plant at C.F. Industries, Inc.	Bartow, Florida	600,000	Start-up by early 1981
Earth Sciences, Inc., at Western Cooperative Fertilizers, Ltd.	Calgary, Alberta	120,000	Start-up February or March 1980
	Total annual recovery capacity =	4,385,000	
Facilities Planned			
J.R. Simplot Company at Don Plant	Pocatello, Idaho	120,000	Construction begins mid-1980
Earth Sciences, Inc., at Western Cooperative Fertilizers, Ltd.	Medicine Hat, Alberta	120,000	Option to build
Becker Industries Corporation at Conda Mine area	Conda, Idaho	200,000	Pilot test planned
	Total planned capacity =	440,000	

STATISTICAL DATA

EXCHANGE VALUE — $40.00/lb U_3O_8

DEFINITION

The Exchange Value is Nuexco's judgment of the price at which transactions for significant quantities of natural uranium concentrates could be concluded as of the last day of the month.

DERIVATION

Nuexco bases the Exchange Value upon:

A. Data from recently completed transactions.
B. Data from pending transactions.
C. Firm bids to buy and firm offers to sell.
D. Prices purchasers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy, and prices sellers have expressed a willingness to accept, but for which Nuexco is not aware of firm offers to sell.

COMMENTS

Nuexco does not consider the following in determining the Exchange Value:

A. The price of uranium delivered or to be delivered under old contracts.
B. The price of uranium delivered in connection with contract renegotiations or other than arm's length transactions.

TRANSACTION VALUE			
$/lb U_3O_8	Millions of Pounds	Number of Transactions	Number of Months
42.00	2.3	14	7

DEFINITION

The Transaction Value is a weighted average price of recent transactions, and is based on prices paid for U_3O_8 in transactions closed within the previous three-month period and for which delivery was scheduled within one year of the transaction date. At least ten transactions totaling at least two million pounds U_3O_8 are included in each calculation, or the sample time is extended as necessary to include these minima. Foreign currencies are converted to US dollars as of the transaction date.

STATISTICAL DATA

Figure 1
HISTORICAL EXCHANGE VALUES

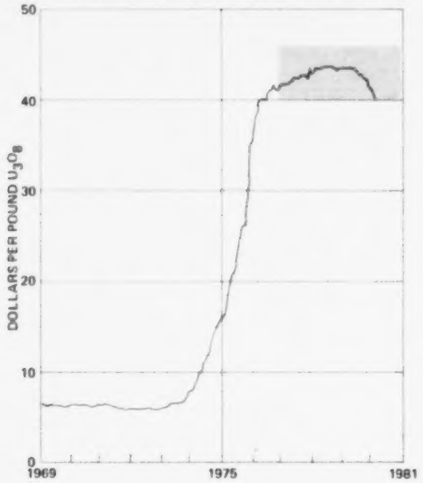


Figure 2
HISTORICAL TRANSACTION VALUES

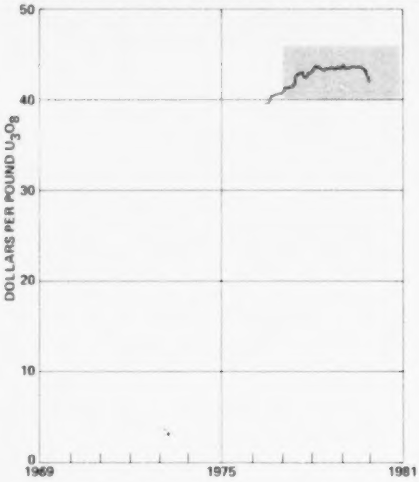
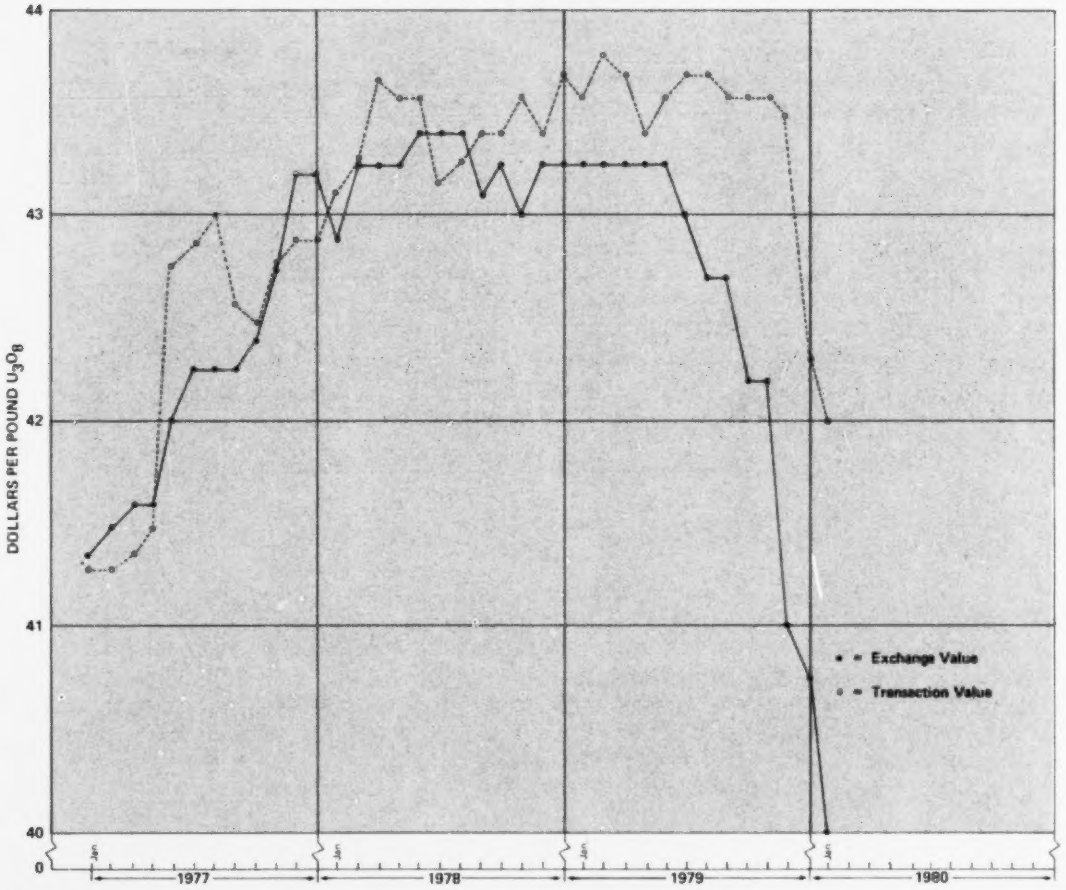


Figure 3
RECENT EXCHANGE AND TRANSACTION VALUES



STATISTICAL DATA

EXCHANGE VALUE
US Dollars/lb U_3O_8

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1968	–	–	–	–	–	–	–	6.35	6.35	6.40	6.45	6.50
1969	–	6.35	6.10	6.10	6.25	6.25	6.20	6.20	6.15	6.15	6.15	6.20
1970	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.20	6.15	6.15	6.15	6.15
1971	6.20	6.20	6.20	6.20	6.15	6.05	6.00	5.95	5.95	5.95	5.95	5.95
1972	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95
1973	5.95	6.00	6.10	6.20	6.45	6.50	6.50	6.50	6.50	6.50	6.75	7.00
1974	7.70	7.90	8.00	9.00	9.50	10.50	11.50	12.00	12.50	14.00	14.75	15.00
1975	16.00	16.00	18.00	20.00	21.00	23.00	24.70	26.00	26.00	28.50	30.00	35.00
1976	35.20	37.00	39.25	40.00	40.00	40.00	40.00	40.40	41.00	41.00	41.50	41.00
1977	41.35	41.50	41.60	41.60	42.00	42.25	42.25	42.25	42.40	42.75	43.20	43.20
1978	42.90	43.25	43.25	43.25	43.40	43.40	43.40	43.10	43.25	43.00	43.25	43.25
1979	43.25	43.25	43.25	43.25	43.25	43.00	42.70	42.70	42.20	42.20	41.00	40.75
1980	40.00											

Note: See earlier Nuexco Reports for evolution of the definition of Exchange Value.

TRANSACTION VALUE
US Dollars/lb U_3O_8

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1976	–	–	–	–	39.60	39.70	39.70	40.40	40.30	40.60	40.70	40.70
1977	41.30	41.30	41.40	41.50	42.80	42.90	43.00	42.60	42.50	42.80	42.90	42.90
1978	43.10	43.30	43.70	43.60	43.60	43.20	43.30	43.40	43.40	43.60	43.40	43.70
1979	43.60	43.80	43.70	43.40	43.60	43.70	43.70	43.60	43.60	43.60	43.50	42.30
1980	42.00											

STATISTICAL DATA

EXCHANGE VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES*

Country	per lb U_3O_8 in Concentrates	per kg U_3O_8 in Concentrates	per kg U in Concentrates
US (dollar)	40.00	88.18	103.99
France (franc)	162.60	358.47	422.73
FRG (mark)	69.50	153.23	180.70
Japan (yen)	9,551	21,057	24,831
Switzerland (franc)	64.88	143.04	168.68
UK (pound)	17.67	38.95	45.93
Australia (dollar)	36.07	79.52	93.77
Canada (dollar)	46.46	102.42	120.78
Niger, Gabon (CFA)	8,130	17,924	21,136
South Africa (rand)	32.68	72.05	84.96

* Calculated using currency exchange rates published in the Wall Street Journal on the last business day of the month.

LOAN USE CHARGE RATE — 7.0%/year

DEFINITION

The Loan Use Charge Rate is Nuexco's judgment of the annual interest rate at which uranium loans could be concluded as of the last day of the month.

DERIVATION

Nuexco bases the Loan Use Charge Rate upon:

A. Data from recently completed or pending loan transactions.
B. Rates included in firm proposals to borrow or lend.
C. Rates that potential borrowers and lenders have expressed a willingness to pay or accept, but for which Nuexco is not aware of firm proposals.

STATISTICAL DATA

CURRENT TRANSACTIONS*

Ref	Delivery Period	Approximate Quantity	Approximate Price as % of Current E.V.	Seller Group	Buyer Group	Remarks
1025	83	100,000 to 300,000 lbs U_3O_8	88%	US	Europe	Not an arm's length transaction
1027	82-90's	2,000,000 to 4,000,000 lbs U_3O_8	–	US	US	Price related to market at time of delivery
1030	80	100,000 to 300,000 lbs U_3O_8	100%	US	US	
1032	80-83	2,000,000 to 4,000,000 lbs U_3O_8	–	US	Pacific Basin	Price related to market at time of delivery

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* Transactions listed include not only those in which Nuexco was involved, but also all others of which Nuexco is aware.

STATISTICAL DATA

US GOVERNMENT STATISTICS

	Producer Price Index—Industrial Commodities	Gross Average Hourly Earnings of Production or Non-supervisory Workers (US$) (2)		
	(1967 = 100)(1)	**Metal Mining (SIC 10)**	**Primary Non-ferrous Metals (SIC 333)**	**Chemicals and Allied Products (SIC 28)**
Annual Avg. 1970 (3)	110.0	3.88		3.69
Annual Avg. 1971 (3)	114.0	4.12		3.94
Annual Avg. 1972 (3)	117.9	4.49		4.21
Annual Avg. 1973 (3)	125.9	4.82		4.48
Annual Avg. 1974 (3)	153.8	5.43		4.85
Annual Avg. 1975 (3)	171.5	6.13		5.37
Annual Avg. 1976 (3)	182.3	6.75		5.89
Annual Avg. 1977	195.1(4)	7.27(4)	7.66(5)	6.39(4)
Annual Avg. 1978	209.4	8.26	8.56	7.01
Oct 1978	214.7	8.60	8.84	7.19
Nov 1978	216.0	8.71	8.87	7.22
Dec 1978	217.2	8.72	8.97	7.28
Jan 1979	220.0	8.71	9.01	7.32
Feb 1979	222.5	8.81	9.02	7.32
Mar 1979	225.4	8.84	9.11	7.36
Apr 1979	229.0	9.03	9.49	7.50
May 1979	231.6	9.06	9.15	7.47
Jun 1979	234.0	9.09	9.44	7.53
Jul 1979	237.5	9.32	9.57	7.60
Aug 1979	240.6R	9.38	9.70	7.65
Sep 1979	243.8	9.63	9.79	7.73
Oct 1979	248.5	9.67	9.87	7.82
Nov 1979	250.2	9.79P	9.91P	7.86P
Dec 1979	252.8			7.92P

P = Preliminary
R = Revised

(1) US Bureau of Labor Statistics, Washington, D.C.; "Producer Prices and Price Indexes," Table 6 (formerly "Wholesale Prices and Price Indexes"). Producer Price Indexes are revised four months after they are first released to reflect the availability of late reports and corrections by respondents.

(2) US Bureau of Labor Statistics, Washington, D.C.; "Employment and Earnings," Table C-2.

(3) Monthly data for these years appear in Section 10 of Report No. 107, dated June 30, 1977.

(4) 1977 monthly data for Producer Price Index, SIC 10 and SIC 28, appear in Report No. 121, dated August 31, 1978.

(5) 1977 monthly data for Producer Price Index, SIC 333, appear in Report No. 125, dated December 31, 1978.

STATISTICAL DATA

AUSTRALIAN GOVERNMENT STATISTICS

	Price Index of Materials Used in Manufacturing Industry – All Groups (Year 1968-69 = 100.0)[1]	Weighted Average Minimum Weekly Wage Rates – Adult Males Australia Mining and Quarrying (A$)[2]
Annual Avg. 1970[3]	101.4	59.88
Annual Avg. 1971[3]	101.5	65.95
Annual Avg. 1972[3]	105.6	71.26
Annual Avg. 1973[3]	124.4	78.96
Annual Avg. 1974[3]	141.9	108.07
Annual Avg. 1975[3]	150.4	132.55
Annual Avg. 1976[3]	168.4	160.93
Annual Avg. 1977[3]	192.0	179.03
Annual Avg. 1978[3]	215.4	190.04
Sep 1978	228.1	190.26
Oct 1978	230.3	190.56
Nov 1978	232.2	190.86
Dec 1978	235.7	199.27
Jan 1979	246.3	199.76
Feb 1979	253.0	200.00
Mar 1979	264.0	201.44
Apr 1979	273.0	202.27
May 1979	287.5	203.37
Jun 1979	293.8	209.87
Jul 1979	295.8P	210.48
Aug 1979	290.8P	211.56
Sep 1979	–	212.33
Oct 1979	–	211.86

P = Preliminary
R = Revised

(1) Australian Bureau of Statistics, Canberra; "Price Index of Materials Used in Manufacturing Industry" (Catalogue No. 6411.0), Table 3.

(2) Australian Bureau of Statistics, Canberra; "Wage Rates, Australia" (Catalogue No. 6312.0), Table 1. Figures for the latest twelve months shown are subject to revision.

(3) Monthly data for 1970 through 1978 appear on pages 4.7 and 4.8 of Report No. 138, dated January 31, 1980.

STATISTICAL DATA

AUSTRALIAN GOVERNMENT STATISTICS

Price Index of Materials Used in Manufacturing Industry
All Groups [1]

	1978	1977	1976	1975	1974	1973	1972	1971	1970
January	197.7	183.4	160.7	144.5	135.1	109.3	101.3	99.0	101.9
February	201.4	187.3	161.1	144.3	139.4	117.9	102.7	100.0	102.3
March	200.7	190.8	161.5	145.8	139.4	122.9	102.7	100.4	103.1
April	203.6	193.1	162.0	148.8	142.2	120.9	102.1	100.5	103.9
May	204.6	193.2	163.8	148.1	142.9	121.6	103.1	101.0	103.6
June	212.2	194.0	167.3	146.7	140.1	122.9	103.3	102.0	102.8
July	216.7	193.3	170.8	148.8	145.8	125.8	106.5	103.9	102.4
August	221.8	194.2	174.0	151.2	146.1	130.0	108.9	104.4	100.3
September	228.1	195.1	174.7	154.4	140.9	130.1	109.5	103.3	99.8
October	230.3	193.7	174.7	157.0	143.1	128.8	109.0	102.3	99.2
November	232.2	191.4	171.3	157.1	142.9	130.2	108.8	100.9	98.0
December	235.7	194.5	179.1	157.9	144.7	132.4	109.1	100.8	99.0
Annual Average	215.4	192.0	168.4	150.4	141.9	124.4	105.6	101.5	101.4

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(1) Australian Bureau of Statistics, Canberra; "Price Index of Materials Used in Manufacturing Industry" (Catalogue No. 6411.0), Table 3.

AUSTRALIAN GOVERNMENT STATISTICS

Weighted Average Minimum Weekly Wage Rates Adult Males — Mining and Quarrying (A$)[1]

	1978	1977	1976	1975	1974	1973	1972	1971	1970
January	185.53	169.15	147.08	122.41	82.47	73.41	68.93	63.76	59.26
February	188.83	169.86	156.77	122.79	85.48	73.76	68.91	63.73	59.45
March	188.92	175.72	156.82	123.16	99.74	75.72	69.14	63.71	59.55
April	188.24	176.50	156.93	123.60	101.78	75.85	69.41	64.60	59.61
May	188.11	180.27	160.74	128.53	111.55	79.46	71.59	64.71	59.65
June	189.88	180.11	161.38	128.05	112.11	80.22	71.89	65.27	59.57
July	189.99	180.27	161.78	127.64	113.13	80.51	72.23	65.56	59.59
August	190.04	183.04	164.60	127.63	112.35	81.15	72.19	65.65	59.82
September	190.26	182.78	164.87	146.00	117.17	81.68	72.30	68.09	59.73
October	190.56	182.64	164.60	146.89	118.55	81.77	72.38	68.51	60.67
November	190.86	182.67	167.62	146.91	119.66	82.02	72.82	68.76	60.85
December	199.27	185.37	168.02	147.00	122.79	82.16	73.30	69.04	60.83
Annual Average	190.04	179.03	160.93	132.55	108.07	78.96	71.26	65.95	59.88

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(1) Australian Bureau of Statistics, Canberra; "Wage Rates, Australia" (Catalogue No. 6312.0), Table 1.

STATISTICAL DATA

CANADIAN GOVERNMENT STATISTICS

	Industry Selling Price Index: Manufacturing (D 500000) (1), (2) (1971 = 100.0)	Wage-earner Data: Average Hourly Earnings ($C) (3), (4)		
		Metal Mining, including milling (SIC 050-059)	**Primary Metal Industries, non-ferrous (SIC 296-298)**	**Chemicals and Chemical Products (SIC 370-379)**
Annual Avg. 1977	174.3	8.18	6.50	6.51
Annual Avg. 1978	190.4	8.76	6.82	6.97
Sep 1978	194.0	9.04	6.89	7.10
Oct 1978	197.6	9.20	7.04	7.13
Nov 1978	198.6	9.18	7.09	7.14
Dec 1978	199.4	9.29	6.93	7.14
Jan 1979	204.8	9.19	7.14	7.29
Feb 1979	208.5	9.24	7.18	7.36
Mar 1979	210.4	9.47	7.20	7.51
Apr 1979	212.8	9.68	7.26	7.63
May 1979	214.5	9.65	7.28	7.61
Jun 1979	216.0	9.49	7.27	7.66
Jul 1979	218.2	9.37	7.34	7.73
Aug 1979	219.8	9.56	7.38	7.77
Sep 1979	223.2	9.75	7.50	7.81
Oct 1979	226.7	9.89P	7.54P	7.88P
Nov 1979	227.4			

P = Preliminary
R = Revised

(1) Statistics Canada, Prices Division, Ottawa; "Industry Price Indexes" (Catalogue 62-011), Table 1. Indexes for the most recent six months shown are subject to revision.

(2) Monthly data for 1973 through 1978 appear on page 4.10 of Report No. 138, dated January 31, 1980.

(3) Statistics Canada, Labour Division, Employment and Payrolls Section, Ottawa; "Employment, Earnings and Hours" (Catalogue 72-002), Table 2.

(4) Monthly data for 1977 and 1978 appear on page 4.11 of Report No. 138, dated January 31, 1980.

CANADIAN GOVERNMENT STATISTICS

Industry Selling Price Index: Manufacturing (D500000)[1]
(1971 = 100.0)

	1978	1977	1976	1975	1974	1973
January	181.5	167.5	158.4	149.3	127.2	108.7
February	182.8	168.8	158.6	150.0	129.1	109.8
March	184.4	171.1	159.2	150.0	131.1	111.3
April	187.2	172.9	159.9	151.4	133.9	112.4
May	188.0	173.9	160.9	152.8	135.7	114.1
June	189.0	174.1	161.5	152.8	136.7	115.0
July	190.1	175.3	161.9	153.9	139.7	116.7
August	191.7	175.8	162.2	155.2	141.8	120.2
September	194.0	176.9	163.4	156.3	143.1	119.9
October	197.6	177.8	163.4	157.4	145.0	120.6
November	198.6	178.6	163.6	157.3	147.0	121.3
December	199.4	179.2	165.6	157.6	147.4	122.8
Annual Average	**190.4**	**174.3**	**161.6**	**153.7**	**138.1**	**116.1**

(1) Statistics Canada, Prices Division, Ottawa; "Industry Price Indexes" (Catalogue 62-011), Table 1.

STATISTICAL DATA

CANADIAN GOVERNMENT STATISTICS

Wage-earner Data: Average Hourly Earnings ($C)(1)

	Metal Mining, Including Milling (SIC 050-059)		Primary Metal Industries, Non-ferrous (SIC 296-298)		Chemicals and Chemical Products (SIC 370-379)	
	1978	1977	1978	1977	1978	1977
January	8.43	7.82	6.70	6.30	6.73	6.23
February	8.53	7.86	6.70	6.26	6.75	6.30
March	8.45	8.02	6.75	6.34	6.84	6.33
April	8.49	8.08	6.73	6.45	6.87	6.40
May	8.51	8.13	6.76	6.50	6.94	6.50
June	8.71	8.15	6.86	6.55	6.95	6.61
July	8.64	8.14	6.66	6.53	6.98	6.61
August	8.70	8.14	6.70	6.57	7.03	6.55
September	9.04	8.33	6.89	6.65	7.10	6.72
October	9.20	8.42	7.04	6.69	7.13	6.63
November	9.18	8.52	7.09	6.60	7.14	6.64
December	9.29	8.57	6.93	6.57	7.14	6.65
Annual Average	**8.76**	**8.18**	**6.82**	**6.50**	**6.97**	**6.51**

(1) Statistics Canada, Labour Division, Employment and Payrolls Section, Ottawa; "Employment, Earnings and Hours" (Catalogue 72-002), Table 2.

MARKET OPPORTUNITIES

Market Opportunities are *active* inquiries in the uranium market to buy, sell, borrow or lend. The data presented in this section are in no way intended to be indicative of the entire uranium market for the time period covered.

SUPPLY

Uranium Available for Sale

Delivery Year	Pounds U_3O_8 (1000's)	Nuexco Reference Number	Remarks
1980	25	1358	
	50	1345	
	200	1236	
	1000	1325	
	100	1292	
	500	1333	
	400	1346	
	250	1338	
	400	1274	
	350	1284	
	250	1353	
	500	1285	
	100	1359	
1981	100	1306	
	300	1274	
	300	1286	
	500	1324	
	200	1236	
	250	1333	
1982	300	1274	
	200	1306	
	300	1286	
	200	1315	
	200	1236	
	250	1333	
1983	300	1286	
	200	1306	
	200	1315	

MARKET OPPORTUNITIES

Market Opportunities are *active* inquiries in the uranium market to buy, sell, borrow or lend. The data presented in this section are in no way intended to be indicative of the entire uranium market for the time period covered.

SUPPLY

Uranium Available for Loan

Delivery Year	Return Year	Pounds U_3O_8 (1000's)	Nuexco Reference Number	Remarks
1980	1982	725	1175	UF_6
	1982	600	1354	
	1982	600	1355	
	1983	2000	1136	UF_6
	1983	1000	1239	UF_6
	1983	700	1234	

MARKET OPPORTUNITIES

DEMAND

Inquiries to Purchase Uranium

Delivery Year	Pounds U_3O_8 (1000's)	Nuexco Reference Number	Remarks
1980	450	1337	
	1000	1334	
	500	1335	
	100	1362	
1981	250	1337	
	800	1260	
	300	1357	
1982	300	1146	
	300	1227	
	250	1337	
	400	1321	
1983	400	1321	
	250	1322	
	300	1227	

Inquiries to Borrow Uranium

Delivery Year	Return Year	Pounds U_3O_8 (1000's)	Nuexco Reference Number	Remarks
1980	1981	500	1120	
	1982	500	1121	
	1983	1000	1240	
	1983	500	1348	
	1983	200	1308	
	1983	800	1034	
	1984	1000	1220	

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EXECUTIVE SUMMARY & INDUSTRY OVERVIEW
NUEXCO REPORT NO. 138

The Committee on Nuclear and Alternative Energy has released its final report to the **US** National Academy of Sciences. Entitled *Energy in Transition, 1985–2010,* the four-year study finds nuclear fission and coal to be the only economically feasible sources of energy for the US for several decades. However, in view of the environmental problems caused by burning coal, and the fact that its use in the production of synthetic fuel will be required, the report concluded that nuclear fuel should be favored over coal for the production of electricity. It is not known what part the report will play in the formulation of US energy policy.

Several countries, including **Italy, Japan, Spain** and the **USSR**, have recently announced progress in their nuclear power programs. **Sweden's** nuclear power referendum, to be held in March, is expected to show its citizens strongly in favor of nuclear power.

The optimum enrichment plant tails assay is expected to increase, as separative work prices escalate rapidly simultaneous to the decline in the price of natural uranium. A higher transaction tails assay will boost uranium requirements somewhat, partially mitigating the decrease in demand of recent years.

Beginning with this Report, selected government indexes for **Australia** and **Canada** will be included in the *Statistical Data* section.

Potential decreases in **South African** uranium production due to a drop in the cutoff grade of gold ore mined are likely to be offset as more gold-bearing areas become economically exploitable, and new tailings recovery operations come under consideration. Indeed, these occurrences could lead to a net increase in uranium production.

In **Australia**, Electrolytic Zinc (EZ) decided to join Peko-Wallsend in purchasing the government's 50 percent share of Ranger. It is likely that Ranger Export Development Company will continue to market the Ranger production associated with Peko and EZ.

US President Carter is expected to order an extension of the March 10, 1980, deadline concerning renegotiation of the US/Euratom agreement for cooperation, as set forth in the US Nuclear Non-proliferation Act of 1978. This would avoid a cutoff of US uranium exports to the Euratom nations as of that date.

The **Federal Republic of Germany** (FRG) led the near-term market activity in the US this month with an inquiry to purchase 1,000,000 pounds U_3O_8 for 1980 delivery. The inquiry is in connection with the US/FRG offset agreement. A total of about 6,000,000 pounds U_3O_8 was offered by US sellers under this inquiry.

Exchange Value decreased $0.75 to $40.00 per pound U_3O_8 this month. Utility inventory holders continue to be a significant factor in the price decline, providing most of the active price competition in the current market. Uranium producers have not been active for various reasons. **Transaction Value** decreased $0.30 to $42.00, and the **Loan Use Charge Rate** remained at 7% per annum.

This month's *Topical Essay* deals with the subject of Forward Costs used in connection with reserve estimates.

Raw Materials concludes the series on by-product uranium from phosphate.

This Executive Summary may be reproduced for internal distribution.

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THE OUTLOOK FOR NUCLEAR POWER IN THE US

by

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President

February 12, 1980

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THE OUTLOOK FOR NUCLEAR POWER IN THE US

INTRODUCTION

Nuclear power expansion in the US remains stalemated, as concern over energy increases. Although the Administration has said that nuclear power is now an essential part of the nation's energy program, government promotion has been ineffective. This report discusses how this situation developed and delineates prerequisites for the expansion of nuclear power in the US.

This discussion assumes that:

- Plants in operation will remain in operation. Shutdowns for safety-related modifications prompted by the Three Mile Island (TMI) accident have caused, and will continue to cause, only temporary losses of production.
- Most licensed projects will proceed. A few cancellations and a number of deferrals are expected. Nevertheless, the predominant majority will be completed.
- Plants which have been ordered, but not yet licensed, are unlikely to proceed for some time.

The discouraging prospects for new plant orders will be substantially worsened if the first two assumptions prove overly optimistic.

PRECIS

1. Study after study (the latest by the National Academy of Sciences) concludes that:
   a. The US will need more electric power.
   b. Only coal and uranium can fill that future need.
   c. The primary need is to shift from an electric power generation system dependent in large measure upon scarce fuels (oil and gas), to one dependent upon plentiful fuels—namely, coal and uranium.
2. The US is steadily decreasing its energy options. Limited supplies of oil and gas, probable restrictions on coal usage, a stalemated nuclear power program leave no other practical alternatives open. National policy decisions must be made and implemented which free coal and uranium from those steadily tightening constraints.
3. Achieving solutions to the long-term energy problem lies almost wholly within the political realm. Fuel is available. Technology is available. A favorable political environment is not.
4. National energy policy, particularly nuclear power policy, is confused. Neither industry nor government understands what is expected of the other. Policies which will attract broad government, public and industry support are urgently needed. Short-term prospects for such policies are dismal.
5. A sense of urgency is not likely to develop until electric power shortages are evident. A few, limited area shortages are probable within the next few years, but they are unlikely to be severe enough to give nuclear power a big boost.
6. Coal will continue to be favored over nuclear power for five years or more. After coal's limitations become more publicly apparent, and nuclear power is more widely perceived as preferable, the revival of US nuclear power will be possible. That may occur in the mid-to-late 1980's. A gradual, rather than rapid, turnaround is probable.
7. From the time nuclear power plant orders effectively halted (about 1975) until a reactivation of orders begins (about 1985), roughly ten years will have elapsed. Siting, design, operating, financing, regulatory, and other conditions will have changed substantially. An industry re-emerging in 1985 is unlikely to have the same conceptual form as that which existed in 1975.
8. Cautious planning by the uranium industry is justified, using these assumptions:
   a. Consumption during the 1980's can be calculated with reasonable confidence, based on plants in operation and under construction. New plants, even if ordered, will have an inconsequential effect before the 1990's.
   b. Uncertainty is largely "downside uncertainty." Potential delays, deferrals and cancellations have a much greater chance of decreasing consumption than do new plants of increasing it.
   c. Few, if any, additional nuclear power plants are likely to be ordered before the mid-1980's. Once new plant orders are placed, there will be time to adjust production accordingly.

THE POLITICS OF NUCLEAR POWER

Energy problems are approached from two fundamentally different points of view—one *political*, the other *economic*. The political point of view sees energy as an instrument which can be used to gain power, a weapon for advancing ideology, and a foundation which, if undermined, can lead to the restructuring of society. The economic viewpoint holds that ample energy supplies are necessary for the material well-being of a stable society.

A report, written ten years ago, concerned with the future of nuclear power would have concentrated on the economic side—cost-of-power, load-growth projections, and technological comparisons. Political considerations would have been secondary.

Today, the situation is dramatically different. Forecasts no longer confidently assume seven percent annual growth. New oil and gas plants are ruled out by law. Nuclear power is enmeshed in political controversy. Coal, once handicapped by its image as a dirty fuel, is now the preferred fuel, mainly due to political constraints on alternative fuels. Passive technologies are promoted for political reasons even though they are impractical for technical and economic reasons. Every aspect of energy is politically influenced—decisively so.

Growth in Politicization of Energy

Early nuclear power development assumed public acceptance would follow as technical and economic solutions became evident. What was not, and could not have been, foreseen was the extent to which nuclear power would become the instrument of political activism. The board of directors of a utility now has to be primarily concerned with whether a site and facility will be licensed, start-up permitted, and continuity of operation anticipated. In such a case, a business judgment is largely a political assessment.

In a substantial way, current social and political influences go back to a shifting public attitude over the past couple of decades. The *first* shift has been an increase in skepticism that technological progress automatically leads to social progress. Anything disciplined, technical, complex, and large tends to be suspect. The *second* major shift resulted from a growing realization that energy is a foundation upon which modern industrial society depends. Factions interested in political influence have, accordingly, jumped into the energy fray.

Energy and Ideology

One aspect of energy which particularly heightened interest by the extreme left is consistent with Marx's theories. Marx was among the first to believe society could be structured according to predetermined concepts. Marx hit upon a concept of government control over the "principal means of production" to provide the leverage.

Marx's fundamentals have not been lost on those concerned with reshaping society. Control of the essential element of production—energy—could lead to control of the "principal means of production," and control of those could lead to political control. Energy moved from the lowest rung on the political ladder, where it resided until ten to twenty years ago, to the top.

Nuclear Power and Ideology

Until the 1960's, American internal political schisms were modest. Later, civil rights, the Vietnam War, Watergate and other issues widened the schisms. Reaction against traditional values grew. The search for new identities produced a segment which sought to be set aside from mainstream society. Political causes having an importance visualized as overshadowing personal destiny became necessary.

A minority developed out of this which constituted an "alienation party" dedicated to opposing society's accepted objectives. A loosely-knit leadership emerged. Ralph Nader, Jane Fonda, Tom Hayden, Bella Abzug, Barry Commoner and Daniel Ellsberg are among the leaders. That leadership has rallied around nuclear power as "The Cause" with rallies, protest meetings, sit-ins and other opposition activities expressing alienation.

The depth of ideological attachment to the nuclear power issue was demonstrated by result of competition with the "Boat People" issue. Millions have died, and may still be dying, in Cambodia and Vietnam. Hundreds of thousands have fled without knowing where, or whether, their boats might land. Joan Baez, the famous singer and human rights advocate, publicly accused the Vietnamese government of gross human rights violations. Nationwide advertisements were published to that effect, with many previous anti-war colleagues as cosigners. Public attention focused on Vietnamese and Cambodian actions.

Jane Fonda took issue with the Baez position. A publicized feud developed as some sided with Fonda for criticizing Baez, and some sided with Baez, who views herself as apolitical. A prominent leftist attempted to defuse the problem in order to minimize the division. Baez, he argued, was wrong for even raising the issue. He said that, "Socialist governments should not be criticized even when they do violate human rights;" and, "Most refugees are of Chinese origin;" and, "Even the American Revolution produced a number of displaced persons." Upon the heels of this reasoning came the key concern: "Another issue should not have been raised if it detracted from leftist concentration on nuclear power." In other words, substance was not that important; political value was.

The "Soft Path"

Since a negative image is not politically desirable, a positive image was needed once it became apparent that a position had developed which opposes virtually all forms of electric power generation. A position developed, in short, which was seriously in need of a rationale. The rationale which eventually emerged found that oil, gas, coal and nuclear constituted the "hard path," with economics setting the course. "Control by corporations," centralized power stations, pollution, etc., had been the result.

The proper alternative, according to the new rationale, was the "soft path" shaped by social policy. The favored energy source has become solar power, which, among other merits, would allow the return to a pastoral society. The theoretically *desirable,* and wholly political, viewpoint was decisively important. Economic and technical *feasibility* was of no concern.

Political Spectrum

Political classifications are difficult to define, as related to nuclear power, but three general groups are of interest. The first is strongly ideological nuclear opposition. Second, at the opposite end, is a strongly pro-nuclear element. Third, and most important, is an in-between group which may become either more or less favorably disposed towards nuclear power.

The ideological group anchors strong opposition on one side; the conservative element anchors the other side. Nuclear power's future will be determined by the delicate balance in the center. Many may favor nuclear power in principle, but are nevertheless concerned about safety, environmental and other problems. Many may oppose having a plant in *their* area, while favoring nuclear power in general.

Nuclear power can move ahead in spite of those opposed to it for radical ideological reasons. A democratic system, in fact, provides for this for reasons which have nothing to do with nuclear power. But nuclear power cannot move ahead without support of the center group, and that has to be strong enough to overwhelm the deep-seated ideological opposition.

GOVERNMENT, CRISES AND PROBLEM-SOLVING

It is widely assumed that crises will force rational government action. As applied to energy, the view is that a shortage of energy will force accelerated construction of new generation capability. Nuclear will be widely perceived as a necessary component.

Unfortunately, history does not demonstrate that rational responses are necessarily the result of crises. The opposite is often the case, as public pressures force expedient solutions.

An electricity crisis is not likely to develop as a clearly visible, well-defined, well-formed crisis. The challenge will be blurred. The nature of government is not such that response can be crisp and immediately effective. The response will be blurred.

A nationwide shortage of electricity will not occur as a single event. The shortage, when it occurs, will more probably be an accumulation of events. Adjustments can be made as best they can, on a gradual basis. Political repercussions will be avoided by selective adjustments (such as cut-backs in aluminum production). A number of variables, as discussed later, will impinge upon the timing of any shortages (such as reserve margin, conservation, plant availability, etc.). Predicting the point at which a shortage will be acute is not practical. Any government response, therefore, is likely to be surrounded by political controversy. Solutions are likely to inch forward rather than develop as major strides.

Government has several basic characteristics which make formulation of coherent policy and its implementation difficult. Three are of special relevance.

The first of these has been aptly labelled "Balkanization of government," and has to do with its size, diversity and external forces.

Government has grown, almost unrestrained, since the 1930's. The causes of this may not be fully understood. Perhaps the national mood favored turning over individual responsibility when government was eager to assume it. Whatever the cause, energy followed the general trend. Energy and government are deeply intertwined.

"Balkanization" entails the division of a problem into that number of parts required to fit the structure of the organization. An oil problem, for example, will involve the Executive Office, Department of Energy, Department of State, Council of Economic Advisors, Council on Environmental Quality, National Security Council and others. Each of those major organizations must subdivide its share of the problem to accommodate its own internal structure.

Government components usually have dual loyalties. One loyalty is to the organization of which it is a part. Another is to the special external constituency viewed as its ally. The Department of Labor, for example, is beholden to unions; the Commerce Department to business; the Environmental Protection Agency to environmentalists, and so on. Adding to centrifugal forces developed by those special interests are those of Congress, with its numerous budgetary, oversight, etc., committees.

The result is that decisions can be arrived at only slowly and with numerous compromises. Coherent, consistent policy is an unlikely response to even a clearly-defined challenge—and it is not likely in a complicated matter such as energy.

A second has to do with natural conflict between national goals and practical politics. Government is forced to operate on dual planes functioning in opposite directions simultaneously, much as trade winds do. National interest carries policy in one direction (such as energy self-sufficiency), while practical politics carries it in another (such as wealth redistribution). The result often produces situations in which one program cancels another. For example, a California tax credit subsidizes solar power in an effort to reduce the use of oil, while a federal tax credit is under consideration to compensate those who must rely on expensive heating oil. Will a tax credit encourage the use of one, but not the other?

A third characteristic concerns use of massive irrationality. Irrationality, if it is major, can form its own politically protective screen providing it is so confusing that it appears that only government can cope.

Examples can easily be found to show how these characteristics, alone or in combination, function in the political system. For example, northern California was victimized by simultaneous electricity and gasoline shortages in 1979. The gasoline shortage, the President advised, would be alleviated if only each California family would reduce consumption by a few gallons per week. The electricity shortage was caused by shutdown of the Rancho Seco nuclear power plant and start-up delays of the twin Diablo Canyon units. Reserve margin had dropped to four percent.

Operation of the three nuclear power plants would have saved oil at a rate of 30,000,000 barrels per year (more than several gallons per family per week), increased the reserve margin to an adequate level, and saved ratepayers many millions of dollars.

The Governor, politics and ideology set aside, had an easy, straightforward opportunity to solve the problems by an accelerated effort to place nuclear stations in operation quickly. His actions, however, were quite different than one might expect. They included urging the President to keep Rancho Seco shut down, participation in an anti-nuclear protest rally at Diablo Canyon, a commitment to the public to do all in his personal power to prevent Diablo Canyon from ever operating, and an attempt to further his presidential candidacy by promising to make the "California Energy Model" the "National Energy Model."

Situations with this type political involvement encourage political panaceas to meet short-term political needs. President Carter has proposed his "Comprehensive Energy Plan" and "Moral Equivalent of War." Governor Brown proposes "a recognition of an era of limits" and "lowered expectations." None stands the test of rational analysis if energy production is an important consideration in the supply/demand balance.

These peculiarities in the political process do not suggest that we should expect a sudden crystallization of understanding for any complex situation. Rather, they suggest that what we are more apt to see is a sort of problem-solving process which takes three steps forward and two steps backward.

EFFECTS OF TMI

Public Acceptance of Nuclear Power

Nuclear power is exceptionally vulnerable to the politics of fear. Radiation cannot be seen, felt, smelled, tasted or heard. That which cannot be sensed can be much more frightening than that which can. Only a small fraction of the public has seen the exterior of a nuclear power station—fewer still the interior. Nuclear power remains unfamiliar to the public in terms of concrete, personal experience.

Most issues which arise within a democracy are resolved by majority vote. A tax issue may arouse debate, but voters accept the outcome. However, an issue which inspires fear cannot necessarily be resolved simply by majority vote. Minority concerns assume a much greater importance. Satisfactory resolution may require overwhelming support.

Many in the nuclear industry tend to take undue comfort in public opinion polls. Although polls usually favor nuclear power by about three to two, this ratio is not sufficient for a dynamic nuclear program. A utility, moreover, cannot rely on national polls for guidance. Even people who favor expansion of nuclear power on a national basis may oppose local construction.

Nuclear Power and the News Media

Every successful political and social movement depends upon support by the news media. Not only does nuclear power not enjoy favorable news coverage, but is portrayed in a way that inherent evils far outweigh inherent virtues. A few examples serve to illustrate:

- A radio announcer, on Albert Einstein's birthday: "Albert Einstein invented atomic energy. He also did many good things, such as . . . "
- During a television interview following TMI, Joseph Califano, then Secretary of Health, Education and Welfare, explained that updated calculations indicated the potential for one additional cancer death among the 2,000,000 people within a 50-mile radius of the TMI site. The expected cancer death rate from natural causes was 325,000 whereas the accident could raise the figure to 325,001. An interviewer's question, antagonistically presented, "Is nuclear power worth even one death?"
- Two months after TMI, a newspaper published 2,000 miles from the scene of the "incident," contained the following Associated Press report: "About two ounces of low-level radioactive water spilled onto a laboratory floor . . . No one was injured and there are no after effects." Merely publishing this sort of trivial occurrence attached to it an importance totally out of proportion to any conceivable justification.

There are some deeply ingrained reasons for biased coverage and most will not change soon. They include:

- The leaders of the news media, on the whole, see themselves as responsible for setting national priorities, and many do not support nuclear power.
- Exaggerated events stressing the humanist viewpoint are most effective as a successful means of market competition. "Potential disasters" receive maximum attention.
- The news media do not police each other. Inaccuracies reported usually go unnoticed and unchallenged. Corrections are usually buried in the back pages, no matter how extensive the original coverage.

– Reporters often do not understand the subject matter.

Example: TMI:s "explosive hydrogen bubble" generated the greatest-ever volume of news for a single event. As was demonstrated later, there had been no potential for explosion.

Example: The evacuation of 144,000 residents from the Harrisburg area attracted enormous attention, while the arrival of hundreds of the world's most knowledgeable nuclear experts at the TMI site was not considered to be newsworthy.

The news media shape public thinking, and public opinion eventually determines political policy. Nuclear power will remain stalemated, regardless of its intrinsic assets and liabilities, until a more positive attitude on the part of the news media builds public and political support.

Nuclear Power as a Presidential Election Issue

Presidential campaigns are currently underway. A new or modified cabinet will be in place in 1981. At least two years of uncertainty lie ahead.

California's Governor Brown has taken progressively more anti-nuclear positions. He supports a moratorium on new construction of nuclear plants, phasing out operating plants, and abandonment of projects in the planning stage. Massachusetts' Senator Kennedy favors a moratorium on new construction, but not the shutdown of operating plants. (New England receives more than one-third of its electric power from nuclear energy.) President Carter, who called nuclear power a "last resort" energy source during his campaign in 1976, is now defending it. All leading Republican candidates support nuclear power.

No one can predict the outcome of the election. Unforeseeable events often play the decisive role. However, the US government, like all stable political institutions, is based on the orderly transfer of power. Each president is bound by past obligations and present realities. Therefore, the longer-term course of nuclear power may depend less on the officeholder than on energy realities. Nevertheless, the possibility of substantial change always exists, and a prudent utility's board of directors must take that into account. It would take unusual business courage to support aggressive nuclear power development without benefit of a positive, or at least neutral, political climate.

Government Safety Regulation

A regulated industry contains within it seeds of danger which may flower when least expected. New problems are met with new procedures. Procedures become crutches. A spread of divided responsibilities may not be recognized either by those being regulated or those providing regulation. Responsibility may unintentionally shift from the operating site—the point of application, to Washington—the point of political focus. Emphasis on engineering safety can become an exercise in pacifying regulatory bodies. An accident such as TMI brings concerns of this type into view as natural defense mechanisms are forced into play.

A virtual nervous breakdown within the Nuclear Regulatory Commission has been one result, understandably, as it has been required to defend its past actions, reorganize, cope with emergencies, review utility operations, consider new licenses and respond to investigative bodies, all in the face of enormous political pressures.

Industry, on the other hand, has invested much time, money and effort in responding to government requirements. After years of coping with continually increasing regulatory requirements—effort which proved inadequate—industry cannot avoid the conclusion that fundamentally new directions are needed. Self-sufficiency will be the foremost aim guiding future development.

One outcome of the TMI accident, therefore, will be a recasting of basic policy. Industry will do whatever is internally necessary to ensure safety. Government may provide a check, but not a crutch. This alone will reshape industry for many years.

Industry Interdependence

The extent to which all the organizations within the nuclear power industry depend upon one another had not been fully appreciated before TMI. Now it is universally clear that an accident at any one plant affects all. Every nation with nuclear power generation capability is considering new laws, regulations and revised programs in the wake of TMI.

The US utility industry has responded vigorously to the lessons of TMI, in part through the Electric Power Research Institute (EPRI). A Nuclear Safety Analysis Center (NSAC) and an Institute of Nuclear Power Operations (INPO) have also been established. Nuclear Electric Insurance Limited (NEI) is being formed to insure utilities against financial adversity. The problem of making fully adequate technical resources available to all utilities, especially those with few nuclear units, is receiving more attention. Investors, management and the public have become much more sensitive to nuclear safety and public attitudes as a result of TMI.

Legal Uncertainties

Numerous legal events which tend to place additional and non-specific obligations upon the industry have taken place.

Third-party Claims Against the Operators and Suppliers: Numerous individual and class action suits have been filed. More are expected.

Indemnification: The Price-Anderson statute limits the amount of nuclear operators' liabilities to third parties. Efforts are being made to declare that limitation invalid if "gross negligence" can be proved.

Price-Anderson Continuation: Lobbying pressure is being applied on Congress to eliminate protection under the Price-Anderson Act for future projects.

Property Damage: As plant values now exceed one billion dollars, property damage is of increasing importance.

Corporate Liability: Although the Karen Silkwood case was unrelated to TMI, the precedent set in the case may be relevant. Karen Silkwood, an employee of a Kerr-McGee Corporation subsidiary, was killed in an automobile accident. An autopsy revealed plutonium contamination. A lawsuit was subsequently brought against Kerr-McGee by the Silkwood estate and the trial jury found in favor of the plaintiff. Damages of $10,500,00 were awarded—the largest ever for such a case. The verdict is under appeal. The merits of the case are not of concern here, but the outlook for industry is. The following concern nuclear power users:

- The plaintiff's legal counsel's style was publicized as being an important factor affecting the outcome.
- The award was made without proof of actual damage. Presumably, plutonium would have caused harm in due time, but death precluded that; proof of actual damage is traditionally required.

- Full responsibility for contamination was placed on Kerr-McGee, which maintained that Ms. Silkwood intentionally contaminated herself. Compliance with government regulations was not an adequate defense in this case, even though government, itself, considered the regulations adequate.

Each adds to an already formidable thicket of legal problems confronting nuclear power.

Financial Uncertainties

The financial structure of a regulated industry is unique. Risk is likely to be borne by shareholders, while benefits are passed, not to them, but to rate payers. Therefore, a low-risk course usually proves most prudent for utilities.

TMI demonstrated problems which made nuclear power appear more risky than alternative technologies from a shareholder's standpoint. A regulatory bias placed a near-maximum financial burden on shareholders for replacement power costs, clean-up costs and rate-base matters concerning both TMI-I and TMI-II. Savings from nuclear operated electricity, which had already been passed along to rate-payers, were apparently not taken into account once the mishap occurred. Partly due to this bias against shareholders, and partly due to licensing uncertainties, some investment advisors believe investments in utilities owning a large nuclear capacity should require a higher rate of return.

Siting Requirements

The accident at TMI initiated a review of siting requirements and pressures for preparation of large-scale evacuation plans. The NRC has even discussed temporarily closing a few plants located in populated areas.

New siting criteria will favor more remote sites and conditions, ensuring that local populations will remain limited over the expected life of a facility. Qualified sites may not be available in some regions.

Technical Infrastructure

The utility industry is aggressively working to provide small nuclear utilities access to technical resources comparable to those available to larger utilities, and to improve generally the support available to all. A perceived current weakness in this infrastructure, however, should not be a serious deterrent to future nuclear projects, as resources will be more than adequate long before any newly-ordered plant begins its operation.

Waste Disposal

Probably the biggest anti-nuclear issue, from a public opinion standpoint, is waste disposal. The opposition claims that nuclear wastes remain radioactive for thousands of years, disposal processes have not been demonstrated and facilities proven capable of surviving the required time have not been demonstrated.

Unfortunately, private industry cannot provide the solutions. Government defines the rules, which are always subject to change. Nor, as the earlier US reprocessing program demonstrated, can industry even be assured that a project will be allowed to operate upon completion. Waste disposal has thus become a ward of the government sector. To date, no process has been chosen by the US, even though the UK and France have processes in practice. A US site has not been selected. Political pressure to avoid proving solutions exist is probably as great as that to demonstrate solutions.

There is little justification from an engineering standpoint to support the degree of political inaction. A typical nuclear power plant uses about 50,000 pounds of enriched uranium each year. Even stored in solid form, as discharged from the reactor, this amounts to only a few hundred cubic feet per year. After fuel is reprocessed, the remaining fission products amount to only about one cubic yard per year. After being formed into glassified bricks (one solution), the volume amounts to only about 90 cubic feet per year. Handling waste from nuclear power plants is a small task compared to most energy waste systems, which involve massive waste volumes.

The structural problem appears, moreover, to be amenable to a straightforward engineering solution. After the plutonium has been removed, the radioactivity of these wastes will decay in approximately 1,000 years, and that is a relatively short period for structures designed to be permanent. The Egyptian pyramids, built using primitive technology, have already survived several thousand years and appear capable of surviving many thousand more.

Here again, engineering is not being permitted to provide the needed solutions. Political and institutional problems dominate and often present more obstacles than solutions.

PRESSURES ON NUCLEAR POWER

Reserve Margin

Reserve margin, the difference between generating capacity and peak load, has increased during the past half-dozen years from a national average of 20 percent to 34 percent. A reserve margin of 20 percent is usually considered adequate. Reserve capacity, however, is not evenly distributed. Margins in some areas may be only 15 percent, and as high as 40 percent in others. The northwestern US, for example, is currently experiencing a shortage, while some other areas enjoy an excess.

If system loads could be optimally distributed by perfect interties, existing capacity could accommodate the next several years' load growth. Perfect distribution is not, of course, possible, although some improvement is to be expected. The greater this improvement, the longer the time during which the present generating system can meet the need and, thus, the later the point at which shortages are likely to occur.

One important political result of the excess of reserve margin is that the public debate can proceed without any concrete impact registering on the public. Shortages may be predicted, but ample electric power remains available. No evidence of difficulty is clearly visible to the public. Until problems are more imminent, the public may view the electricity generating problem more as a subject for debate than one for action.

One can predict with reasonable accuracy the growth of generating capability for the near term as the sum of existing capacity and projects in progress. However, predicting demand is more difficult. Less predictable influences are involved. Effective conservation and more efficient distribution may defer demand for an uncertain period. The rate of economic growth is also uncertain. The combined effects make it difficult to predict precisely when acute shortages will occur.

This is not to suggest that skimping on capacity is desirable. The cost of excess capacity is small compared to the alternative. Inconvenience and economic loss from inadequate power can be severe. A shortage, moreover, can lead to public pressure for the most expedient solution. That would probably be gas turbines, as they can be placed in service in roughly half the time required for alternates.

Conservation

Correlations between past electricity demand and Gross National Product (GNP) growth show that each one percent increase in real GNP has resulted in about a 1.5 percent increase in electricty demand. While possibly correct for a low-cost energy economy, the same correlation will probably not hold in a high-cost energy economy. A high-cost energy economy is a new development and correlations have yet to be established.

Conservation was, at one time, not fully appreciated as an energy solution. The potential has been underestimated. Awareness of conservation potential has increased as the ethical component and the cost-effective component come into play. Conservation for ethical reasons appeals to basic American anti-waste attitudes. Cost-effectiveness responds to indisputable economic laws.

Early assessments of conservation were based largely on benefits to be derived from elimination of waste. A one-time reduction of seven to ten percent was the popular estimate, and only equal to about one year's growth with normal rates of increase in electricity demand. The importance of conservation as a long-term solution was, therefore, discounted.

But those estimates were before cost-effectiveness began to encourage savings and to attract ingenuity. High costs are encouraging searches for equal results with less energy—results which will reduce energy consumption surface in various ways. Two examples illustrate:

- The landlord of Nuexco's Menlo Park headquarters reduced energy consumption by more than 70 percent by lighting modifications, the curbing of waste and specially-designed microprocessor controls.
- Government is about to impose a "windfall" profits tax on oil companies. Consumers will buy $200,000,000,000 in taxes with their energy budgets, rather than fuel.

Electricity load-growth projects, for all these reasons, have steadily declined. Five years ago, most assumed a continued expansion of six to seven percent per year. Estimates were reduced to five or six percent several years ago. Recent estimates were three to four percent. The potential savings from waste elimination alone may now equal several years' growth. Conservation may move the once-expected shortage of the early 1980's to the mid-1980's, or beyond.

Conservation requires neither new plants nor fuel, produces no waste and has few opponents. Ideologic controversy is difficult to develop. All the indicators point toward an increasing role for conservation in the total energy solution.

Solar Power

The most fraudulent idea being perpetrated on the public today is that solar power will somehow produce significant amounts of electricity. Only the "technology" remains to be developed. Anti-nuclear, anti-growth groups promote this for their own reasons. Industries, believing they are acting as good citizens, add to the conspiracy by advertising solar research and development as though solar electricity is on its way. Government responds to what it perceives to the public interest by increasing appropriations. A wishful public is eager to believe. The news media are easily excited by the desirability, if not the practicality, of solar power. All of this, despite the fact that economical solar electricity will not occur this century and possibly not in the next.

Solar power's problems begin with nature. The sun spreads low-level energy over large areas and follows daily and seasonal cycles. Effectiveness varies with the weather.

One solution usually offered to these problems is that of providing storage of power for use under adverse conditions. One unit would store energy during favorable conditions while another unit serviced immediate demand.

The solar storage plan has several major weaknesses, not the least of which is the economic one that any usable solar electricity storage system will also be suitable for storing electricity produced by any other source. Proving that solar energy provides the best means for charging that storage facility would be most difficult on any conceivable economic grounds. Solar power would have to compete with *incremental* costs of existing systems operated during off-peak hours. Geothermal power, hydroelectric power, nuclear power, coal, gas and, finally, oil, would be preferred in approximately that order. Capital-intensive solar power would be last in line in incremental competition.

This does not mean that the development of some solar power will not proceed, even though it is uneconomical for electric power. One company recently totaled federal tax credits associated with pending legislation. They equalled 80 percent of project cost. California allows a separate tax credit of 55 percent. Thus, profit (at taxpayer expense) might be realized merely by installing an uneconomical solar system.

System Obsolescence

Generating-system obsolescence is an emerging problem. Both economic and physical obsolescence are closing in.

Prior to 1974, it was not easy for a power plant to become economically obsolete. Oil cost $2 per barrel. Fuel costs for 1000 MWe of capacity might have been $20,000,000 per year. Now fuel costs for the same capacity exceed $200,000,000 per year, and may soon exceed $400,000,000 per year. (Nuclear fuel costs, in comparison, are about $40,000,000.) As oil costs increase, and they will continue to do so, economic pressure to use fuels other than oil will also grow. The nearly 15 percent of the nation's oil-fired generating capacity is already economically obsolete, but replacement would cost more than $100,000,000,000.

Throughout this century, electric generating capacity has doubled each decade. As a consequence, most equipment is relatively new. Half has operated only ten years, but almost 40,000 MWe worth of equipment is more than forty years old. By the time replacements could be in service, that early equipment will be fifty to sixty years old. Within another ten years, an additional 75,000 MWe worth of equipment will be more than forty years old. Every decade will see a doubling of obsolete equipment.

While all power plants have shown a remarkable durability and performed longer than first expected, sooner or later age must take its toll.

Oil

If oil prices have not already made all oil-fired stations obsolete, that will soon be the case. The US cannot limit oil prices as long as it depends on imports for the bulk of its supply. Regulated limits on imports will only provide the basis for increased import prices. Long-term oil consumption will be limited only by consumer resistance. OPEC will adjust, so that a natural economic limit set by market price is slightly lower than the regulatory limit, whatever that may be. The lower the mandatory limit on imports, the higher the price.

The only practical course is a phasing out of oil-fired plants. The only open question is what will replace those.

Gas

Natural gas is more readily available than oil. Gas, however, is not a long-term solution. The Fuel Act of 1978 prohibits the construction of new gas-fired plants and provides that existing gas-fired plants be converted to coal by 1990. Even without legal constraints on the use of gas for electricity generation, gas would still be uneconomical in the long run. Economics will direct use of gas towards applications which cannot be supplied easily by electricity—such as petrochemical feedstocks and transportation.

Coal

About half of US electric power was produced from coal in 1979. Coal is, moreover, the nation's most abundant fuel and is counted upon as a primary fuel of the future. Coal, like all fuels, has problems, many of which are related to the massive quantities involved. A 1000 MWe plant may use more than 800,000 pounds per hour. Roughly 15 percent of that, or 120,000 pounds per hour, will become solid ash. The balance of 680,000 pounds in some form, plus oxygen, will be released to the atmosphere. These emissions include particulate matter, oxides of carbon, nitrogen and sulphur, radionuclides, and other products whose effects are controversial. In addition, 10 to 15 percent of the heat generated is released to the atmosphere. "Acid rain," weather modification and ash disposal are matters of growing concern.

Expanded use of coal is expected to cover:

Conversion – oil and gas plants are being converted to coal

Synfuels – coal is planned for gasoline production

New plants – nearly all electricity generating plants ordered since 1975 utilize coal. Virtually all those ordered in the next five years will also depend on coal.

New uses do not, of course, require an immediate increase in coal utilization. A new coal plant requires eight to ten years for completion. A synfuel plant may take longer. Even conversion from oil to coal utilization requires several years. However, during the next five to ten years, limitations in transportation, waste disposal, mining and environmental concerns will reach more controversial levels. Some believe a ceiling on coal utilization may occur in the 1990's.

Other Alternatives

Geothermal steam is an attractive alternate energy source, but suitable locations are few. During twenty years of aggressive development in California (an especially favorable location), Pacific Gas & Electric Company has placed in operation a total of slightly more than 600 MWe, or half the capacity of a single nuclear plant. Alternate sources, such as wind, biomass, wave power, etc., have many shortcomings similar to those of solar power. All only nibble at the total problem. None alters significantly the ultimate reliance upon coal and uranium.

PREREQUISITES FOR REVIVAL OF US NUCLEAR POWER

Some believe that US nuclear power programs will be "allowed" to proceed under increasingly stringent government safety controls. Being "allowed" is not likely to prove sufficient for growth of the industry. Government, moreover, might even decide the nuclear power programs can proceed, but the final decision in the private sector will be made by investors. Until government policy is backed by concrete assurances satisfactory to those investors—and that may require Congressional action—private utilities may be unwilling to proceed.

A decade ago, nuclear power had an advocate within the government, the Atomic Energy Commission. Mechanisms were developed to encourage use of nuclear power. The change to a "neutral" government atmosphere abolished that Commission, and with it began the disintegration of coherent government nuclear power policy. Government policy has since grown increasingly wary of nuclear power for political reasons, despite the economic and environmental advantages. Conditions worsened after TMI.

What preconditions are necessary to change this trend? What will provide investors with confidence to allocate the enormous funds required? Conditions probably include:

- Positive, or at least neutral, press coverage.
- Strong public acceptance in the area of proposed sites.
- Assurance that the NRC is stable and well-organized.
- Assurance that waste disposal is not a problem which will inhibit progress.
- Belief that alternate technologies, like coal, would not better serve the interests of the shareholder, as well as those of the customer.

The current Congressional mood is not encouraging to nuclear power; rather, the opposite is the case. More and more restrictions are proposed for an already stalled nuclear industry. Conditions which barely allow nuclear power generation need to change into conditions which provide assurance of stability. A public attitude may have to develop with due recognition of:

- The visible threat (or actual experience) of a shortage of electrical energy.
- The need for additional generating capacity is essential.
- Nuclear power as a *necessary* component of future needs.

Congressional action will probably not lead public opinion by much. When public opinion is sufficiently supportive:

- Government may urge utilities to build nuclear plants.
- A workable regulatory and legal framework may be restored.
- Government guarantees may be provided to ensure stability and investor confidence.

A wholesale reversal of the current attitude will provide the turning point at which nuclear power once again becomes an important element of industry.

SPECULATIONS

An industry in which further growth of new plants has been suspended for five years, new plant orders might not be placed for another five years, and is in process of critical internal and external re-examination, is not likely to reappear in the same form. A major reshaping is to be expected. One can envision circumstances which will required accommodation, and the impact some may have.

- Public attitude will influence new site selections with government criteria and constraints fashioned accordingly. Very likely, only remote sites will satisfy new criteria.
- Qualified sites will be rare and each will need to be utilized to the fullest extent practical. Multiple units, perhaps as many as a dozen, might eventually be located at one site. This "park" concept will be more attractive.
- Once clustered in this fashion, integrated design and operation of the complex is a necessary consequence. (Much like the Savannah River and Hanford plants.) New complexes may include on-site provision for waste disposal, transportation and, possibly, reprocessing. A high degree of self-sufficiency is to be expected.

Design of a complex will be approached differently than that of a single plant. More consideration has to be given to local conditions and interplant relationships. Single plants have been designed with a dominant emphasis on the nuclear steam supply system. The pervasive influence of the nuclear steam supply system has tended to decrease, and now constitutes approximately 15 percent of the cost of the nuclear plant, rather than the nearly 50 percent it once was. Moreover, the steam supply system warranty, which once set minimum boundaries for scope of supply, has become less important. This once-rigid boundary has become more flexible and thus allows more flexibility in engineering approach.

One can envision, therefore, the evolution of both a reshaped supplier industry and a reshaped utility operating industry. Forms of ownership and cooperation may be drastically changed and comprehensive engineering will gain importance, while the influence of nuclear steam supply system suppliers may decline. US industry practice may resemble more its foreign counterpart, with a greater degree of plant engineering and nuclear steam supply integration.

A frequent question is whether nuclear plant suppliers will remain capable of supporting a viable plant program. The following argues they will. General Electric began assembling an organization to produce the first commercial nuclear power plant, the 200 MWe Dresden I, in late August of 1955. Recruitment, organization, technical development, design, manufacture (including construction of manufacturing facilities) and construction followed. The plant achieved criticality in October 1959, approximately four years and two months later.

Nuclear resources available to General Electric at the time were largely limited to those which could be drawn from Hanford and Knolls Atomic Power Laboratory. Today, organizations and facilities are already in place. A strong base is available as a result of fuel and services businesses. A technical cadre is available. The resources are there, even though not in the optimal form for a large and rapid build-up.

The problem of greatest concern is whether the procedural obstacles will be manageable. The tendency to equate safety with rigidity of control has increased. The time needed to bring a plant online will also increase. Mounting controls and procedures can suffocate the industry.

If government does accommodate public acceptance needs, does provide a constructive financial and legal framework, and if complexes, rather than individual plants, are the focus of new construction, then changes of many types will probably result. Financing, ownership, design and operation will all be affected in many important ways.

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MONTHLY REPORT
ON THE URANIUM MARKET

NO. 139
MARCH 1980

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NUEXCO

MONTHLY REPORT ON THE URANIUM MARKET

No. 139 March 1980

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FOREWORD ii

THE URANIUM MARKET
- PUBLIC AND GOVERNMENT POLICY 1.0
- GENERAL 1.0
  - Summary of Activity in 1979 1.0
  - Government Statistics 1.2
- AUSTRALIA 1.2
- CANADA 1.3
- FAR EAST 1.3
- UNITED STATES 1.5
- PRICING 1.6

TOPICAL ESSAY
- MARKET PRICING 2.0

RAW MATERIALS
- URANIUM DEPOSITS OF SOUTH AUSTRALIA 3.0

STATISTICAL DATA
- EXCHANGE AND TRANSACTION VALUES 4.0
- LOAN USE CHARGE RATE 4.3
- CURRENT TRANSACTIONS 4.4
- GOVERNMENT STATISTICS 4.5

MARKET OPPORTUNITIES
- SUPPLY 5.0
  - Uranium Available for Sale
  - Uranium Available for Loan
- DEMAND 5.1
  - Inquiries to Purchase Uranium
  - Inquiries to Borrow Uranium

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FOREWORD

This month, the cover format of the Nuexco Monthly Report has been changed somewhat. Also, the dating of the Report has been changed to the month in which it is actually published. However, the date on which the Exchange Value, Transaction Value, and other data in the Report are determined remains the last day of the month prior to the month of publication. Thus, the Exchange Value published in this Report was determined as of February 29, 1980.

At the Atomic Industrial Forum's Fuel Meeting in New Orleans, Nuexco will host a luncheon for its Subscribers and their guests on Wednesday, April 16, at 12:30 p.m. Invitations will be issued later, but please reserve the date.

PUBLIC AND GOVERNMENT POLICY

In the **US**, the Nuclear Regulatory Commission (NRC) has ended its self-imposed licensing moratorium. The NRC voted unanimously to allow the Tennessee Valley Authority to begin startup operations of unit No. 1 of its Sequoyah plant. The go-ahead for Sequoyah is expected to open the way for several other plants which have been completed, but remain unlicensed due to the NRC's moratorium.

Democratic challengers of US President Carter have become more strident with anti-nuclear rhetoric. In their campaigns for the New Hampshire presidential primary, Senator Kennedy and Governor Brown attempted to win anti-nuclear votes by debating which of the two is the more anti-nuclear, and became so earlier. Both Kennedy and Brown were apparently trying to appeal to the opponents of the Seabrook nuclear plant, located in New Hampshire. Carter won the Democratic primary, held February 26.

Three US nuclear plants (Farley No. 1, Arkansas Nuclear No. 1, and Vermont Yankee) were forced to shut down because of inability to meet an NRC deadline of January 31, 1980 for certain safety changes. Meanwhile, New York State regulators refused an application to build the two Jamesport nuclear units. Instead, a coal-fired plant was approved for the Jamesport site.

A nuclear waste program was sent to Congress by the Carter Administration. The report concludes that both defense and industrial nuclear waste can be safely buried, and time is not of the essence. A site is to be selected by the mid-1980's. The program calls for a full-scale repository to be available by the mid-1990's.

The US announced a cutoff of shipments of phosphate fertilizers to eastern Europe, as part of the Administration's policy on Afghanistan. However, none of the US phosphate producers which recover uranium as a by-product export phosphates to eastern Europe, and are thus not directly affected.

Mexico has reaffirmed its interest in proceeding with nuclear power, partly as a means of conserving its oil resources. Study contracts have been awarded to Swedish, French and Canadian firms in an apparent move to reduce technical dependency upon the United States. The move is interpreted as a reaction to the widely unpopular US nuclear power export policies.

The latest public opinion poll regarding the March 23 nuclear referendum in **Sweden** indicates that 54 percent of the voters are pro-nuclear, 32 percent are against nuclear power, and 14 percent are undecided. Sweden currently has six nuclear units in operation. In addition, fuel loading has commenced at two new units, Forsmark No. 1 and Ringhals No. 3. However startup will not occur until after the referendum, if the outcome is pro-nuclear.

In the **UK**, the government anticipates adding another 15,000 MWe of nuclear capacity, which it hopes will bring nuclear power's share of electric generation up to the 30 percent level. The new units will be pressurized water reactors, and a demonstration 1100 MWe unit is scheduled for construction beginning in 1982 at Sizewell.

GENERAL

Summary of Activity in 1979

Nuexco estimates of world uranium production in 1979 is summarized in Table A. Production for 1978 is also shown for comparison.

Table A

ESTIMATED WORLD URANIUM PRODUCTION
(millions of pounds U_3O_8)

	1978	1979
United States	37.0	37.0
Canada	17.5	15.0
Republic of South Africa	10.3	12.5
Other Africa	15.0	22.0
Other nations*	7.2	9.5
TOTAL	87.0	96.0

*Does not include Communist areas.

Production in the US was about the same in 1979 as it was in 1978. However, average grade of ore fell considerably, from about 0.13 percent U_3O_8 in 1978 to about 0.11 percent in 1979. Thus, even though some new US production centers began operation in 1979, the new production was offset by the lower average grade of ore being processed. The 1979 production level is about twelve percent below that predicted by DOE in late 1978.

URANIUM MARKET

Estimated production in Canada during 1979 decreased from 1978. About sixty-five percent of Canadian production in 1979 was from the Province of Ontario, at an average ore grade of about 0.10 percent U_3O_8. The remainder of Canadian production came from the Province of Saskatchewan, at an average ore grade of about 0.34 percent U_3O_8. The overall Canadian ore grade in 1979 averaged about 0.18 percent U_3O_8.

Since ore grade in the US will probably continue to decline, Nuexco now expects that US production in 1980 will be about the same as 1979 production. Total world uranium production (outside Communist areas) in 1980 will probably be around 100 million pounds U_3O_8, with most of the expected increase coming from Africa.

For comparison, Nuexco's estimates of 1979 U_3O_8 consumption (quantities of U_3O_8 which were needed to fabricate fuel for reactors operating or under construction—see Nuexco Report No. 132 for complete definition) are 26 million pounds for the US, and 74 million pounds for the total world (outside Communist areas). Thus a large percentage of world uranium production is being added to commercial inventories, which are approaching 200 million pounds U_3O_8, exclusive of stragetic stockpiles.

Total nuclear electric generation for the world (outside Communist areas) increased only slightly from 1978 to 1979. Figures for nuclear generation in 1978 and 1979 are tabulated in Table B for North America, Western Europe and the Far East. Nuclear Electric Production decreased in the US in 1979, due in part to a licensing moratorium by the US Nuclear Regulatory Commission. Net gains in Europe, the Far East and Canada more than offset the reductions in the US.

Sweden and Switzerland continue to lead in total dependence on nuclear power. About 22 percent of total 1979 electric power generation in those two countries was nuclear. Belgium's usage was about 19 percent; France 16 percent; the UK and the FRG each were about 13 percent. In the Far East, the nuclear power dependence of Japan was about 13 percent, Taiwan 16 percent, and Korea 10 percent. In North America, nuclear dependence of the US was about 11.5 percent. In the Province of Ontario, where all of Canada's operating nuclear plants are located, nuclear power production in 1979 exceeded 30 percent of its total electric power output.

Table B

NUCLEAR ELECTRIC POWER GENERATION
(millions of megawatt-hours, gross)

	1978	**1979**
North America		
Canada	33	38
United States	293	271
Total North America	326	309
Western Europe		
Belgium	13	12
Finland	3	7
France	31	40
FRG	33	40
Italy	4	3
Netherlands	4	4
Spain	8	7
Sweden	24	21
Switzerland	8	12
UK	37	39
Total Western Europe	165	185
Far East		
Japan	51	62
Rep. of China (Taiwan)	3	6
Rep. of Korea	2	3
Total Far East	56	71
TOTAL	547	565

In 1979, sixty-nine uranium sales transactions were completed of which Nuexco is aware. Those transactions involved a total of nearly 60 million pounds U_3O_8. Forty-one of those transactions (about 9.3 million pounds) involved delivery within one year of contract signature. The balance of twenty-eight transactions (about 49.5 million pounds were longer-term. The 1979 transactions are tabulated by buyer and seller region in Table C.

During 1979, Nuexco reported its computations of apparent future consumption (Report No. 132), estimated world uranium production (Report Nos. 133 and 134), and the natural uranium supply demand balance (Report Nos. 135 and 136). These data have been recomputed to account for the

Table C

1979 URANIUM TRANSACTIONS BY REGION

Seller Region	**Buyer Region**	**No. of Transactions (Quantity—millions of pounds U_3O_8)**
US	US	32 (30.5)
US	non-US	16 (8.5)
non-US	US	2 (1.1)
non-US	non-US	19 (18.7)
	TOTAL	69 (58.8)

recent changes in the uranium market, and a Nuexco Topical Report summarizing the current supply/demand picture is in preparation, and will be sent to Subscribers shortly.

Government Statistics

Additions. Beginning in this issue, Nuexco will reprint the US Consumer Price Index and the US GNP Implicit Price Deflator. Current data will appear monthly in the **Statistical Data** section, with the other US Government Statistics. Data on these indexes for the years 1970 through 1978 are reproduced on pages 4.6 and 4.7 of this Report. Data for 1979, some of which are still subject to revision, are on page 4.5.

Revisions. Recent months have seen substantial revisions in the historical data of the US Bureau of Labor Statistics (BLS) industry employment series. Revisions in the Average Hourly Earnings data reprinted by Nuexco are tabulated on pages 4.7 and 4.8 of this Report. These data supersede those published in previous issues of the Nuexco Monthly Report.

The data revisions have arisen from two sources. First, the US BLS periodically adjusts its industry employment series to more recent bench marks (comprehensive counts of employment) to correct for sampling variability and for changes in industrial activity. Beginning with the October 1979 issue, "Employment and Earnings," published by the BLS, has adjusted data to the most recent bench mark, that of March, 1978. The next bench mark will be published in late 1980. At that time, monthly data after March, 1978 will be subject to adjustment to the new bench mark.

The second reason for data revision concerns changes in the Standard Industrial Classification (SIC) system. The SIC system is used to achieve uniformity and comparability in the presentation of industry data, as well as to describe structural changes that occur in the economy. The SIC manual has recently been revised. This is the first major industry reclassification since 1957. Data published in this issue of the Nuexco Monthly Report are based on the revised SIC manual ("1972 SIC Manual").

US BLS Average Hourly Earnings data for the years 1970 through 1978, as adjusted for the new SIC manual, are tabulated on pages 4.7 and 4.8 of this Report. Adjusted data for 1979 are on page 4.5. Data for the years 1970 through 1976 are based on the March 1977 bench mark. Data for 1977 and later are based on the March 1978 bench mark and are subject to revision from March 1978 forward with the publication of the next bench mark in late 1980.

AUSTRALIA

Queensland Mines has announced, based on assays of samples taken from some 8,900 truckloads of extracted ore, that its Nabarlek stockpile contains at least 26,500,000 pounds U_3O_8 at an average grade of 2.35 percent U_3O_8. Mining of the deposit was completed during 1979. Prior to mining, it was estimated that the deposit held about 20,000,000 pounds.

A comparison among the three Australian deposits from which sales have beenk authorized (Nabarlek, Ranger, and Yeelirrie) reveals significant differences in tonnage, grade, production cost, production schedule and risk. Not surprisingly, individual marketing strategies have tended to emphasize relative strengths and ignore potential weaknesses. However, the ability of the Australian sellers to take full advantage of these differences is considerably reduced by government policy, particularly in pricing. This policy is enumerated in determination letters from the government to the individual sellers which authorize discussions between sellers and potential customers, and stipulate certain minimum terms and conditions which must be included in any agreement.

There are several reasons for the Government's approach. First, uranium has been, and continues to be, a politically sensitive issue in Australia. Governmental control of uranium safeguards and end-use is of critical political importance. Second, also having political overtones, the government must be seen to be ensuring that Australia receives fair value in work markets for its exports, particularly in the energy area. Finally, from a legal standpoint, by using its sovereign powers to compel specific market behavior by its producers, the government intends to insulate them from further antitrust problems.

In this last regard, it may be noted that the current litigation involving Australian sellers has had no appreciable effect on marketing efforts. While the Australian government views the situation as extremely serious, sellers and many potential buyers see the situation as little more than an inconvenience which necessitates some ingenuity in structuring new commercial terms regarding passage of title, payment and shipment.

The formation of Energy Resources of Australia (ERA) continues to progress. The contemplated ownership breakdown has been adjusted as follows:

Peko-Wallsend—	30.5%
Electrolytic Zinc—	30.5%
Share offering to Australian investors—	14%
Foreign Uranium Interests—	25%

Transfer of the government's share to ERA is expected by mid-May and the share float to Australian investors will be completed by the end of June. With respect to the non-Australian investors, recent press reports in Australia note that negotiations of the terms under which these investors would take up equity in ERA are stalled. At issue is the insistance of the prospective foreign equity owners that, in return for their investment, they be granted price concessions on their share of the output. The Australian government is refusing such concessions, maintaining that its directives with respect to export sales are equally applicable to all, since any such concession would undermine the marketing efforts of all other Australian sellers.

It seems likely that the publicity about this impasse represents merely a stage of what is, no doubt, a complex and difficult negotiation. Both parties want the deal, and, without either losing face, it should be possible to resolve the issue with creative approaches in such areas, as taxes, interest rates, production costs, and return on investment.

Progress continues to be made at the Ranger project site. Figure A is a recent aerial photograph which shows that the site has been completely cleared, and the foundations of the processing plant are well under construction. A close-up photograph of the processing plant is shown in Figure B. Figure C is a plan view of the project site, included for comparison purposes.

CANADA

The British Columbia provincial government declared a seven year moratorium on uranium mining and exploration within the province. British Columbia does not have any operating uranium production centers. Most directly affected would be the Blizzard property, jointly owned by Norcen Energy Resources, Ltd., E&B Explorations, Lacana Mining Corp, and others. The owners of the Blizzard property had previously signed long-term supply contracts with Korea Electric Company.

The Liberal Party's return to power probably signals continued government intervention in Canada's uranium activities. However, the uranium producers have generally called for a reassessment of some of Canada's uranium policies. Of particular concern to the producers is the reaction among consumer nations to Canada's safeguards policies regulating the end use of its uranium. Other government policies have also been criticized as tending to put Canadian suppliers at a competitive disadvantage, such as the requirement for annual price renegotiation under long-term contracts, and the restriction of export contracts to ten years duration, with an additional five years contingent upon the state of Canadian reserves. These and other regulations are being attacked by producers as no longer necessary, and perhaps harmful to Canada's long term interests, especially in view of the substantial recent increases in Canadian reserves.

FAR EAST

Japan's anticipated 10 percent equity interest in Energy Resources of Australia (ERA), the new corporate entity that will own Ranger's Jabiru deposit, will be divided among three Japanese utilities and C. Itoh and Company, as follows:

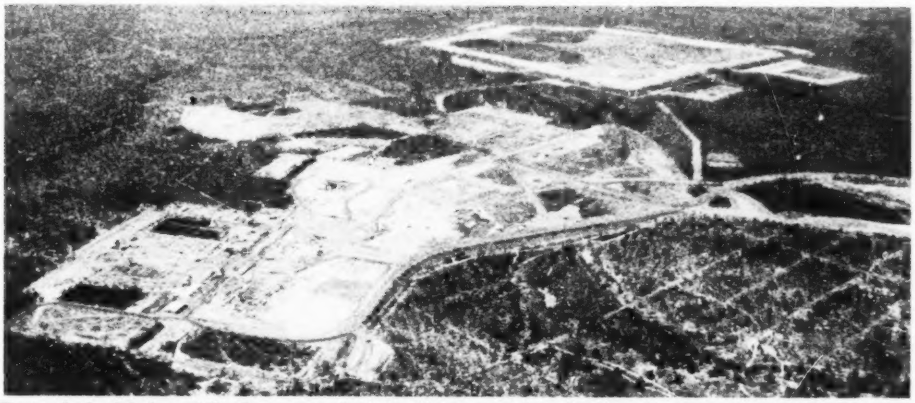


Figure A. Aerial view of the Ranger project site, the processing plant is in the foreground, left. The mine-site is in the center left. The tailings dam is in the background, right.

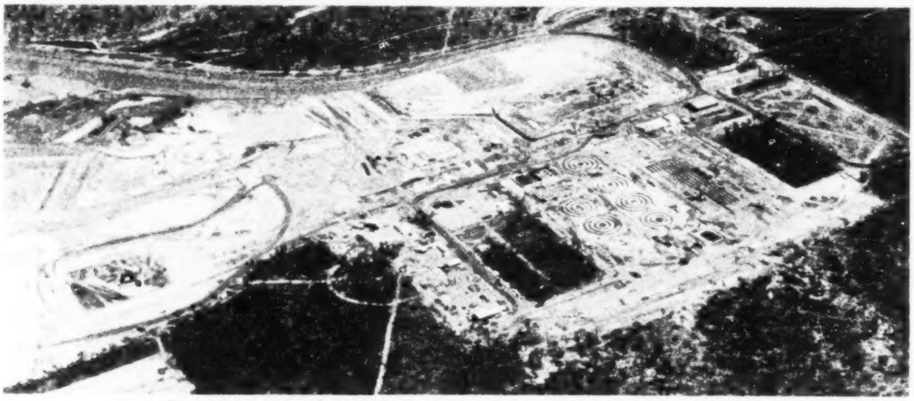
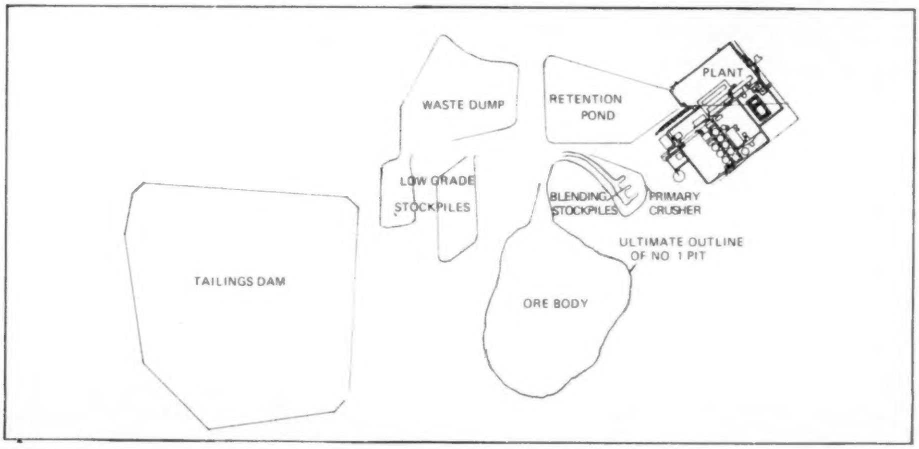


Figure B. Close-up aerial view of the Ranger processing plant site.



PLANT
WASTE DUMP
RETENTION POND
LOW GRADE STOCKPILES
BLENDING STOCKPILES
PRIMARY CRUSHER
ULTIMATE OUTLINE OF NO 1 PIT
TAILINGS DAM
ORE BODY

Figure C. Plan view of the Ranger project site, showing the relative location of the major components.

Japanese Interest in ERA

Kansai	5.0%
Kyushu	2.5%
Shikoku	1.0%
C. Itoh	1.5%

C. Itoh's share will eventually be sold to another Japanese utility, with Chubu being the likely buyer. Although firm tonnage commitments have yet to be established, it is likely that the Japanese would seek to limit their tonnage in the early years, perhaps to that represented by their equity interests, and to commit to take additional quantities beginning in the late 1980's.

In addition to ERA, Australian tonnage will also be committed to Japan by Queensland Mines (QML) during 1980. These sales are related to the loans made to QML to finance the development of its Nabarlek project. Although contractual details have yet to be finalized and approved by the government, it is understood that letters of intent exist covering 6,000,000 pounds.

More than any other nation, Japan has evidenced the greatest concern about security of supply. Its relative inventories are the largest, as are its forward commitments both in time and quantity. The situation should be one of reasonable comfort, even by the very conservative standards of Japanese utilities. Future participation in the spot, near term and intermediate markets is unlikely unless contracted supply is disrupted. In the longer term market emphasis will be in securing post-1990 supply by gaining favored positions in exploration, development and production ventures through equity and related types of financial participation.

An announcement was made this month of a large sale by a US producer to the **Republic of Korea**. UNC Resources sold 3,160,000 pounds U_3O_8 to Korea Electric Company, with delivery extending from 1980 through 1983. The Korean nuclear program continues to expand; Korea has one nuclear unit (587 MWe) in operation, six more nuclear units (about 5100 MWe) under construction, and four more (about 3600 MWe) in active planning. By 1990, government plans call for 18 units in operation, providing 43 percent of the nation's electric power. A recent government analysis has concluded that by the year 2000, Korea will need 44 nuclear units in operation, with a total nuclear capability of 48,000 MWe, or about 60 percent of its total electric generation capacity. Korea is now heavily dependent on imported petroleum (about 60 percent of 1979 energy use) and the push to nuclear power is aimed at decreasing that dependency.

UNITED STATES

The New Mexico legislature has passed the following new severence tax schedule, which represents about a fifty percent increase over the former schedule:

U_3O_8 Price ($/lb)	**Tax Rate ($/lb)**
20–25	1.10, plus 9% over $20/lb
25–30	1.55, plus 10% over $25/lb
30–40	2.05, plus 11% over $30/lb
over 40	3.15, plus 12.5% over $40/lb

The US Department of Energy (DOE) has published (45FR3948) a new schedule of uranium feed prices, as follows:

	$/lb U_3O_8	**$/kg U as UF_6**
Emergency sales or leases of feed	43.74	118.58
Long term sales of enriched product	21.60	60.46

A UF_6 conversion price of $4.30 per kg U as UF_6 was apparently assumed by DOE in the above prices. In this regard, Nuexco has noted that a few holders of conversion contracts are currently offering to sell conversion services on the secondary market, as described in Nuexco Report No. 138. Prices being discussed are in the range of $1.50 to $1.75 per pound U as UF_6 ($3.30–$3.85 per kg U as UF_6).

As recently as mid-1978, nearly 30 US utilities were involved to some extent in uranium exploration or development. There has been a noticeable decrease, however, both in the actual number participating and the general level of activity. Only twenty utilities are still involved at all, and no others are known to be giving it serious consideration. The gradual exodus of utilities from direct participation in uranium production is another indication that buyers generally perceive uranium supply to be adequate. US utility direct participation in uranium activity is summarized in Table D.

Table D

US Utilities Involved in Active Exploration or Development Projects

Utility	**Associated Company in Uranium Exploration and/or Production**
Arizona Public Service	Kerr-McGee
Baltimore Gas & Electric	Intercontinental Energy
Commonwealth Edison	Cotter Corp.,* Edison Nuclear*
Consumers Power	Plateau Resources*
Detroit Edison	St. Claire Corp.*
Duke Power	Ogle Petroleum
Gulf States Utilities	Felmont Oil & Gas
Long Island Lighting	Bokum Resources
Middle South Utilities	Trost & Assoc., Alaska Exploration
Niagara Mohawk	U.S. Steel
Pennsylvania Power & Light	URADCO*
Portland General Electric	Trost & Assoc.
Pacific Power & Light	Nuclear Dynamics
Southern California Edison	Rocky Mountain Energy
San Diego Gas & Electric	Rocky Mountain Energy
Tennessee Valley Authority	Mobil, Federal-American Partners, UNC Resources
Utah Power & Light	
Washington Public Power Supply System	
Wisconsin Public Service	Dolores Bench Mining*
Texas Utilities	Ranchers Exploration and Development Co.

*Subsidiary company of utility

PRICING

The **Exchange Value** dropped again this month to \$38.00 per pound U_3O_8, a decrease of five percent from last month. In the last 12 months, the Exchange Value has dropped 12 percent. In the same twelve month period, the US Producer Price Index—Industrial Commodities, has increased about 18 percent. Thus the real decline of uranium prices over the last year is closer to 30 percent.

The major reason for the downward pressure on the uranium market is obvious from a glance at the Market Opportunities Section of this Report (page 5.0). Material currently being actively offered for sale, available for 1980 delivery, comes to about four million pounds U_3O_8, or eight times the amount of material actively being sought for purchase, as of the end of February.

The market was very active during the past month. Eight spot or near-term transactions closed in the US. The range of prices, as tabulated on the Current Transactions page of this Report (page 4.4) is indicative of the dynamic nature of the current market. Leading the activity was the offset purchase by the Federal Republic of Germany. Over six million pounds U_3O_8 was offered in response to the German inquiry. While it is significant that about half of the material tendered was offered by inventory sellers, it is equally significant that the remainder was offered by US producers, thus indicating substantial unsold 1980 production. Following on the heels of the German purchase, several near-term buyers surfaced in the US. This made for a spirited spot market, as some of the unsuccessful offerors to the German inquiry attempted to attract those new buyers. The result was additional downward pressure on an already declining market.

The near-term uranium market has become increasingly complex. No longer are we limited to producers selling to utilities. Falling ore grade, rising production costs, and a declining uranium price have put some producers in a position where economics might favor purchasing uranium on the spot

URANIUM MARKET

market, rather than producing it themselves, in order to deliver under long-term contracts. At the same time, the utility inventory seller remains a strong force in the market. Thus we might see producers buying uranium from utilities, or from other producers, utilities buying from other utilities, as well as utilities buying from producers.

While inventory sellers provided most of the initial downward momentum to the near-term market price, several US producers have begun to meet the competition. Thus we no longer have the seller side of the near-term market being dominated by inventory holders. As a result, several producers were successful in closing sales during the past month.

The slippage in the near-term market will very likely bring some confusion to the longer-term market. A strong buyer's market will probably make utilities even more unlikely to contract long-term if the price at the time of delivery might exceed the then-perceived market price. Sellers would be equally hesitant to contract long term without reasonable assurance that the contract would be profitable. And in the absence of sales commitments, new US production will not be forthcoming, and some existing, economically marginal US production will be phased out. To the extent that they are permitted to do so by their governments, low-cost producers from Australia and Canada might be able to sell on terms which US utilities find acceptable. Thus the uranium industry might be approaching the same crossroads that many other mineral industries have faced in the past; that of either favoring what could be lower priced imported supplies, or supporting, perhaps even subsidizing, domestic production.

This decision is especially complex due to the nature of the uranium users, the electric utilities, and the nature of uranium itself. For example:

—The utility operates in a goldfish bowl environment. Every move is likely to be second guessed by regulatory agencies, which are well aware not only of the price the utility pays for its uranium, but also of the generally perceived market price of uranium at any point in time.

—Unlike traditional utility fuels, oil and coal, uranium is produced as a standard concentrate. One producer's uranium is about as good as another's. Thus delivered prices for uranium are directly comparable among all utilities.

—Unlike oil and coal, the transportation cost of uranium is a very small fraction of the delivered price, again making utility purchases comparable.

—Regulatory agencies are unlikely to distinguish between uranium purchased on the near-term market, and uranium purchased under long-term contracts.

Thus for the first time utilities are using a fuel which is fungible on a national, or even a world level. Therefore, the utilities are often under a great deal of political pressure to pay no more than the generally perceived market price at the time of delivery. US producers are of course under just as much pressure, albeit economic pressure, to produce at a profit. With the market price falling, and costs rapidly escalating, there appears to be little likelihood of extensive long-term contracting between US producers and US utilities in the near future, since their current priorities are generally so out-of-phase. The net result may be a considerably smaller US supply sector than had once been anticipated.

Although in the longer term, it is apparent that prices must move higher if a substantial US production industry is to be maintained, it is equally apparent that near-term prices will continue to be determined by the supply/demand balance. The market is now out of balance, but lower prices can be expected to perform their classical economic function of bringing new buyers into the market (such as producers buying rather than making), and removing some sellers (such as inventory sellers deciding not to sell at the weaker prices).

Due to the large number of transactions which have recently closed, the **Transaction Value** has also changed substantially. This month's Transaction Value is $39.30, a decrease of more than six percent from last month. This month's calculation of Transaction Value is based on more recent data than last month's. The required minimum sample of ten transactions and two million pounds extended over a seven month period in Report No. 138, versus only three months in this Report. (See definition of Transaction Value on p. 4.0.)

TOPICAL ESSAY

MARKET PRICING

Introduction

The subject of market pricing has been touched on in earlier Topical Essays. Such pricing often appears in intermediate-term and long-term uranium contracts and represents an attempt by the parties to deal with an uncertain future price situation by establishing procedures to arrive at a contract price which reflects market conditions at or near time of delivery. While this goal is theoretically reasonable, its successful application has proved both elusive and difficult, as demonstrated by the wide variety of contract approaches adopted over the past six years, as buyers and sellers sought to handle the practical problems associated with the concept.

Market pricing first gained credibility in the US with the announcement, in the fall of 1974, that TVA and Rio Algom (Canada) had adopted it in a 12-year agreement involving 17,000,000 pounds U_3O_8. Public accessibility to the TVA/Rio contract language provided a starting point, and variations of this general approach proliferated. This type of market pricing is described as the *negotiated* approach, as distinguished from the *reference* approach, which is discussed later in this essay.

Negotiated Approach

The main elements of the negotiated approach include the following:

1. *Definitions:* Typically defined are such terms as *pricing year, delivery year, buy price, sell price, settlement price* and any other terms necessary to the particular approach used.

Of particular importance is the pricing year, or when a particular delivery is priced. In earlier versions of the negotiated approach the price negotiation was conducted two to three years prior to delivery. Thus, price negotiations for deliveries in calendar year 1980 might have commenced in January 1978. However, more recent contracts provide for negotiations to start one year prior to delivery and, in some cases, in the last few months of the year prior to the delivery year. This change suggests that the contracting parties have determined that more effective and enlightened negotiations are possible when conducted closer to the delivery period.

2. *Objective:* A statement of what the parties intend to achieve. It will typically contain language to the effect that the parties intend to agree upon a price which reflects prices being paid under similar, arm's length uranium contracts. Of course, as more market priced contracts reference other market-priced contracts, the objective becomes less meaningful.

3. *Negotiation Sequence:* Outlines which party acts when. For example, the buyer might propose the first price, with the seller given two weeks to accept or counter. Or, the seller might propose first, or proposals might be exchanged simultaneously in sealed envelopes. Provisions are normally made for a period of discussion and/or further exchange of prices. Some contracts provide that, in the case of a simultaneous exchange of prices, if the proposed prices are within *X* percent of each other, they are immediately averaged to arrive at the market price.

4. *Experts:* If negotiations between the parties fail to produce agreement, the usual next step is to appoint an expert. Procedures are set forth for the expert's appointment, submissions of prices to the expert, any submissions of evidence supporting the proposed prices, and rules governing the experts' conduct, compensation and decision process. The decision process is of particular importance. Early contracts typically provided that the expert had to select a price between those proposed by the buyer and the seller. Evidence suggests that this procedure did not work as well as was hoped. A more common procedure currently in use is referred to as "baseball arbitration," in which the expert selects either the final price submitted by the buyer or the final price submitted by the seller. No compromise is permitted. It has been found that this procedure, with its attendant risk of winning or losing everything, has led to more responsible and effective negotiations, with most being settled prior to the arbitration stage.

While most negotiated market pricing involves some variation of this basic approach, there are other, fundamentally different, approaches. Of particular interest is one that provides for establishment of an initial market price which remains in effect until one of the parties requests establishment of a new market price. The intent is to avoid unnecessary negotiations in a static market, and to provide the opportunity for more frequent negotiation in a rapidly changing market. Advocates of this approach note that since the uranium market *per se* does not recognize the beginning and ending of specific time periods (calendar years or delivery years), there is no reason for the parties to obligate themselves to an expensive and time-consuming exercise when it is not clear that a negotiation will be either necessary or appropriate.

A second variation follows the standard negotiated approach, with the exception that there is no provision for experts. In this variation, failure by the parties to agree on a market price results in a partial or complete termination of the contract. Typically, deliveries will continue for some defined period—such as one year—following termination, in order to provide each party the opportunity to make alternative arrangements.

A third, quite different, approach involves an arrangement under which the pricing provisions with respect to future deliveries are agreed upon by the buyer and seller at some future date, prior to such deliveries. Of note is the fact that no mechanism, other than good faith negotiations, is specified. It is, in effect, an agreement to agree. Characteristic of this approach is the TVA/Pathfinder agreement of 1979. Deliveries are scheduled in the years 1981 through 1990, but only those during the 1981–85 period are priced, while the pricing mechanism for the 1986–90 deliveries is to be negotiated during 1984.

This type of arrangement is somewhat unusual, particularly for US buyers, which prefer precise price definition or, failing that, definition of the mechanism by which the price will be determined. A contract which lacks such procedures and precision in these areas suggests that the parties anticipate a relationship different from the conventional buyer-seller adversary relationship. An initial, firm contract period is linked to a later period by ongoing delivery obligations, subject only to agreement on price. The reopening allows each party the opportunity not only to consider price, but also to reexamine its own particular needs, the other's performance, the market place and the advantages and disadvantages of continuing the relationship. Such an approach is unlikely to be acceptable unless each party is satisfied that the other is responsible, financially sound, sophisticated in uranium market matters and likely to deal in good faith. This would, in turn, suggest that the parties may have dealt previously with each other. It would also tend to limit this approach to the larger nuclear utilities, and the larger, established uranium producers.

Reference Approach

The reference approach to market price determination involves the use of data from published, publicly-available sources. Current, prior and prospective sources include:

1. *Nuexco:* Nuexco's Exchange Value has been used in some contracts. Normally the Exchange Value used is that published on the last day of the month prior to the month in which delivery occurs. The principal variation on this scheme is the use of a moving average of several months' Exchange Value.
2. *Metals Week:* This McGraw-Hill publication has discontinued publication of uranium prices after successively (a) publishing its own price, (b) publishing its own price and Nuexco's Exchange and (c) publishing only the Exchange Value. Metals Weeks has been referenced as the source of uranium prices in at least one contract.
3. *American Metal Market:* This Fairchild publication is referenced as the source of uranium prices in at least one contract. At this time, American Metal Market publishes Nuexco's Exchange Value.
4. *US Department of Energy* (USDOE): USDOE publishes several types of price data including:
    (a) Weighted average price paid for all deliveries to US utilities during a given year. This historical figure is published annually, normally in May or June of the following year.
    (b) Weighted average settlement price paid by US utilities under market price contracts for all deliveries during a given year. This historical figure is also published annually in May or June of the following year.
    (c) The emergency feed price.

With the exception of the emergency feed price, all of USDOE's data are historical, and are generally viewed within the industry as being of little use in current market price negotiations.

5. *NUKEM Price Quote:* Quotations by this German nuclear fuel company are published monthly and are characterized as being the range of bids and offers in the European market.
6. *Uranium Price Information Service:* This ser-

vice developed by Nuclear Assurance Corporation is in its formative stages. The type, utility, public availability and industry acceptance of its data are as yet unknown.

7. *Conventional Commodities Market:* As discussed in Nuexco Report No. 137, there is no conventional commodities market in uranium, and no market maker. Although various commodity exchanges have studied the possibility, to date none has found an acceptable approach. However, were such a cash market established, it would be expected to define market price for uranium, much as the London Metal Exchange (LME) does for copper and other metals.

A variation of the reference approach involves utilization of a published source or sources, in combination with some mechanism which the parties agree reflects longer-term price trends. Such a mechanism might be a cost-plus formula, or a base price adjusted by changes in published government indexes. Thus, price movements in published sources which reflect short-term market fluctuations would be moderated when averaged with some agreed-upon mechanism that reflects longer-term trends.

The primary advantage of a reference approach to market pricing is its simplicity and ease of use, compared to the negotiated approach. However, both buyers and sellers generally perceive a major disadvantage of this approach, namely that prices in a long-term supply agreement should not be dictated by reference sources which have historically been more reflective of spot and near-term markets. The willingness of market participants to utilize a reference approach to market pricing will be a function of their confidence that the source selected will accurately reflect their views of market level.

As noted above, published sources have, to date, tended to reflect the spot or near-term market and, as a consequence, are apt to move up and down in response to short-term market influences and the transitory market perceptions of buyers and sellers. Such movements may have little or no relationship to cost-of-production and return-on-investment which, in time, will really determine the long-term price trends in a free market. However, the shortcomings of reference sources for uranium prices are shared by many other commodities which are usually bought and sold on the basis of a cash quote on the LME, or other exchanges, even though the sale may be under a long-term contract.

URANIUM DEPOSITS OF SOUTH AUSTRALIA

Introduction

The Liberal Party regained control of the South Australian government from the Labor Party on September 14, 1979. One of the new government's first acts was to announce that uranium mining within the stae would be allowed to go ahead subject to approval of an environmental impact study. The abrupt reversal of the "no mining" policy initiated by the Labor government several years earlier was a sudden and dramatic development in general and the uranium industry in particular. Plans to develop certain uranium deposits are already underway.

Uranium mineralization is known to exist in a number of locations throughout South Australia, from the town of Myponga in the south to Mount Painter and Roxby Downs in the north. It occurs primarily in association with crystalline rocks(granitic and metamorphic) of Lower Proterozoic Age in the Olary and Mount Painter districts, and in Tertiary rocks of the Lake Frome district. Figure D is a general location map of known radioactive occurrences throughout the state.

Exploration History

The first uranium discoveries in South Australia were made by early prospectors looking for gold, silver and copper. Uranium was discovered at Radium Hill in 1906. The prospector who made the discovery thought the mineral was tin, and he immediately began to develop the property. A vertical shaft was sunk to a depth of about 70 feet before the principal mineral contained in the ore was identified as davidite, a uraniferous iron titanate. The davidite occurred as vein material in fractures and shear zones within metasediments of Lower Proterozoic age. The property was mined intermittently as a source of radium bromide until 1914, but it was not until 1954 that full-scale mining was resumed by the South Australian Department of Mines. The mine closed in 1961 when ore reserves were exhausted. Total production was 954,000 tonnes of ore at an average grade of 0.133 percent U_3O_8. A total of 2,540,000 pounds U_3O_8 were recovered.

Primary and secondary uranium minerals were discovered in association with copper mineralization at Mount Painter in the Flinders Range around 1910. The primary mineral uraninite (uranium oxide) occurs in unaltered granite breccia of Archaean Age. The secondary minerals torbernite (phosphate of copper and uranium) and autunite (phosphate of calcium and uranium) were later identified in highly altered and fractured breccia. However, the grade of the uranium proved to be too low for commercial exploitation—less than one pound U_3O_8 per metric ton of ore, and property development was abandoned.

The State Department of Mines explored the East Painter areas extensively during 1946-50. Uraninite and/or torbernite mineralization was discovered at twenty-three separate locations, associated with granitic breccia similar to the main granite mass at Mount Painter. The evaluation program included almost 3,000 feet of exploratory drifts and over 7,000 feet of diamond drilling, primarily around the outer edges of brecciated granite. Program results indicate the presence of several million tons of torbernite mineralization at grades of 0.5 to 1.5 pounds U_3O_8 per metric ton.

Uranium exploration was encourage by the Australian federal and state governments beginning in 1944. Tax incentives were granted and large numbers of prospectors and companies took up the search for uranium. Most discoveries made during the subsequent 12 to 15 years were made by prospectors using hand-held Geiger counters. Some later discoveries can be attributed to airborne radiometric surveys.

Anomalous radioactivity was discovered near the towns of Houghton and Kersbrook in 1950. The State Department of Mines initiated an evaluation program which determined that low-grade uranium mineralization occurred at the outer contact of the Houghton Diorite of Archaean age and younger metasediments of Prosperozoic Age. The uranium mineral present is extremely fine grained, and is thought to be an iron-titanium-uranium oxide, similar to davidite. Locally, carnotite (postassium-uranium vanadate) is a common product of alteration, showing high-grade mineralization. Although assays exceeding one percent U_3O_8 have been recorded, the average grade of the uranium was estimated to be between 0.01 and 0.04 percent U_3O_8—too low to be economically ex-

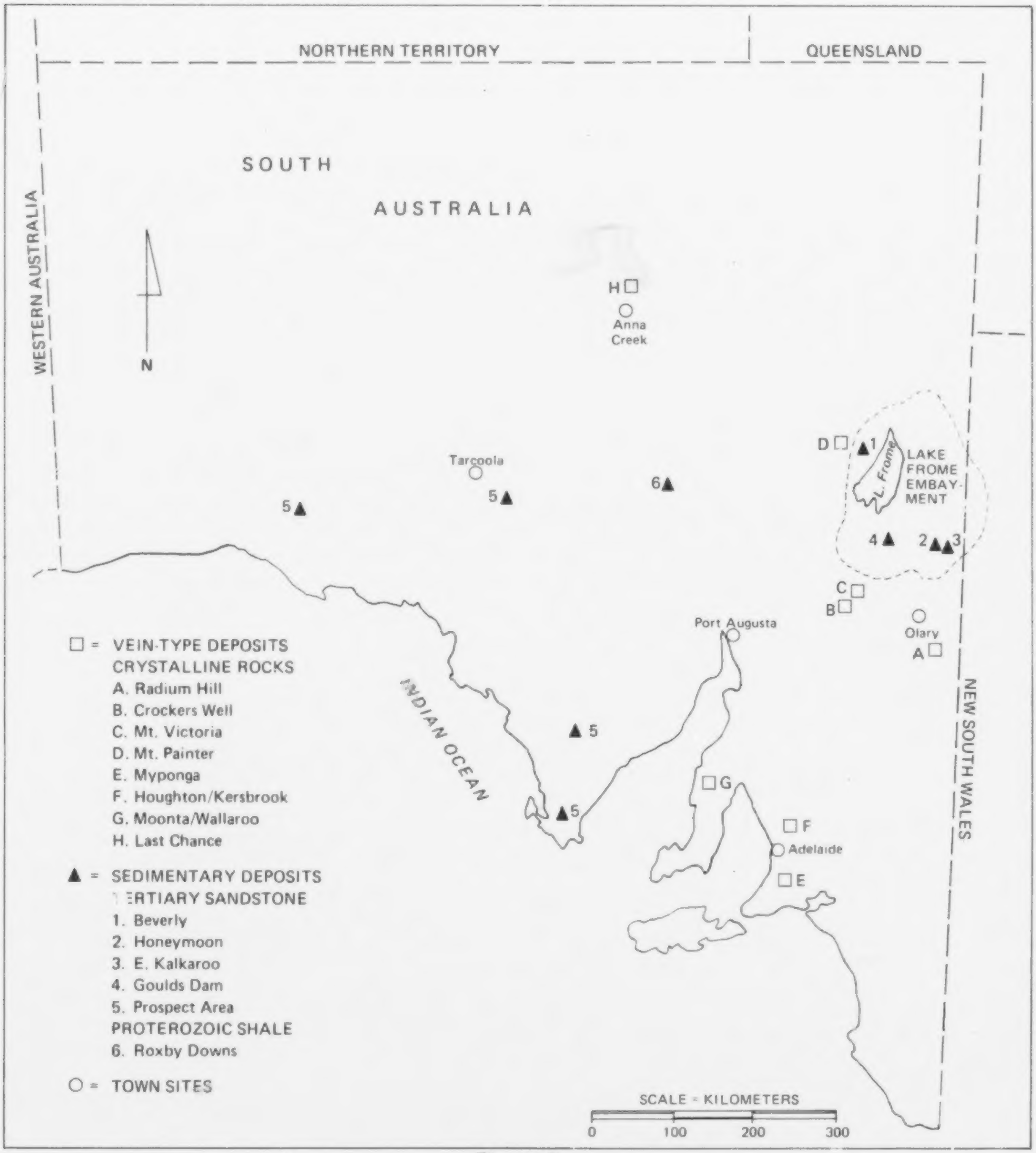

NORTHERN TERRITORY
QUEENSLAND
WESTERN AUSTRALIA
SOUTH
AUSTRALIA
N
H
Anna Creek
D
1
L. Frome
LAKE FROME EMBAYMENT
Tarcoola
5
5
6
5
4
2
3
C
B
Olary
A
Port Augusta
INDIAN OCEAN
NEW SOUTH WALES
5
G
5
F
Adelaide
E
□ = VEIN-TYPE DEPOSITS
CRYSTALLINE ROCKS
A. Radium Hill
B. Crockers Well
C. Mt. Victoria
D. Mt. Painter
E. Myponga
F. Houghton/Kersbrook
G. Moonta/Wallaroo
H. Last Chance
▲ = SEDIMENTARY DEPOSITS
TERTIARY SANDSTONE
1. Beverly
2. Honeymoon
3. E. Kalkaroo
4. Goulds Dam
5. Prospect Area
PROTEROZOIC SHALE
6. Roxby Downs
○ = TOWN SITES
SCALE = KILOMETERS
0
100
200
300

Figure D
URANIUM DEPOSITS OF SOUTH AUSTRALIA

ploited. Similar radioactive occurrences have been noted further south at Myonga. Uraninite was identified as the uranium mineral present, but the concentration of uranium is too low to be of economic interest.

The State Department of Mines continued its aggressive exploration program for uranium, primarily in the Olary Province. In mid-1951, a new discovery was made at Crockers Well. Uranium mineralization was noted to occur as finely disseminated particles throughout a fractured breccia zone within a coarse-grained granite (alaskite). The uranium mineral was identified as a hydrous thorium-uranium-titanium oxide, very similar to brannerite. However, it was considered to be a new mineral species, and was given the name *absite*. The principal difference between the two minerals is the content of thorium and water. Absite contains almost three times as much thorium and twice as much water as does brannerite. Absite has not been identified at other prospects in the region, or elsewhere in the world.

Five exploratory shafts were sunk on the breccia zone to evaluate the mineralization. It was estimated that the property contained ore reserves of 11,000 metric tons at an average grade of 0.40% U_3O_8. The reserves were not mined at the time, due to unfavorable economics.

The uranium occurrences at Mount Victoria were discovered by the State Department of Mines in 1954, during systematic radiometric prospecting and geological mapping of the rock outcrop area. The uranium mineral davidite occurs in highly fractured and intruded metasediments of Lower Proterozoic Age, similar to the Radium Hill deposits. Following a trenching and sampling program, about 11,000 feet of diamond drilling were completed. Drilling results indicate a total of 93,000 metric tons of probable and possible ore at an average grade of 0.30 percent U_3O_8. The deposit was not mined at the time, however development plans are presently under consideration by North Flinders Mines.

The State Department of Mines has continued its search for uranium, which has resulted in a number of less significant discoveries, all confined to metasediments and intrusives. Each prospect was carefully evaluated for economic potential. The areas include Windamerta North and South and the Last Chance Mine—three prospects where secondary uranium mineralization occurs in metasediments and Old Boolcoomate, and primary uranium minerals occur in pegmatite dikes and breccia within metasediments. Other prospects of note are Nichols Nob, Moonta, Kulgera Station, Kings Bluff and Wiperaminga Hill, to name a few. Perhaps some of the early discoveries will be of interest to future uranium prospectors.

Current Exploration & Development Activity

The uranium program that was supported by the federal and state governments ended in the late 1950's and exploration activity in South Australia declined rapidly. However, further interpretation of information generated by the State Department of Mines later proved instrumental in the discovery of important new uranium deposits in South Australia.

Interest in uranium exploration was renewed in the late 1960's. The first important new discovery in South Australia was made in 1969 in Tertiary lake sediments of the Lake Frome Embayment—the first sedimentary basin in Australia known to contain uranium.

The Lake Frome Embayment is a structural basin bounded on the west by the Flinders Range and on the south by the Olary Range. Lower basin sediments consist of Cretaceous shales and sandstone overlying Precambrian granites. The Cretaceous section is overlain by Tertiary sediments about 400 meters thick. Several uranium deposits have been discovered in the upper half of the Tertiary sequences since 1969, although uranium does not seem to be present in the Cretaceous rocks.

The largest uranium discovery in this environment is the Beverley deposit. Exploratory drilling began at the foot of Mount Painter in an attempt to locate uranium redistributed by ground water from the Mount Painter deposits. Drilling progressed nearly 16 kilometers eastward into the basin before the first ore was discovered, at a depth of about 100 meters. The mineralization occurs at the oxidation-reduction interface of multiple horizons within paleochannel sand units of the Eocene and Miocene sedimentary sesquence. The main ore mineral is fine-grained uraninite, although coffinite occurs in small amounts. The ore deposits characteristically resemble the roll-front deposits common to Wyoming Tertiary basins. Ore reserves have been estimated at 35,000,000 pounds U_3O_8. It is probable that the ore will eventually be mined by open-pit methods. Property owners are Western Uranium Ltd. (Phelps Dodge Corp.) 50%; Transoil 16-2/3%; Oilmin 16-2/3%; and Petromin 16-2/3%.

The Honeymoon deposit was discovered during test-drilling in mid-1971. Geologically the deposit resembles Beverley, except that the main ore mineral is coffinite. Ore reserves are estimated to be about 7,500,000 pounds U_3O_8 at an average ore grade of 0.22 percent U_3O_8. It has been determined that the ore can be recovered using *in situ* leaching techniques. Plans to proceed with a pilot test plant are under consideration at this time. The property is owned by Carpentaria Exploration Company Pty. Ltd., 49%; Teton Drilling Co. Pty. Ltd., 25.5%; ARR Ltd., 21.675%; and IOL Petroleum Ltd., 3.825%.

The East Kalkaroo deposit is located about eight kilometers east of Honeymoon. Orebody characteristics are the same as Honeymoon except that the ore occurs higher in the Miocene sedimentary sequence. Indicated ore reserves have been estimated at about 2,500,000 pounds U_3O_8 at an average ore grade of 0.15 percent U_3O_8. Orebody characteristics indicate that it would be amenable to in-situ leaching. The ownership of this property is the same as the Honeymoon deposit.

The Goulds Dam ore deposit is located at the southern end of the basin. Its geologic characteristics resemble those of the Beverley deposit. Inferred ore reserves have been estimated at about 4,000,000 pounds U_3O_8. The potential to recover the ore by *in-situ* leaching techniques is being examined. The property is owned by CSR Ltd., 51%; Mines Administration Pty. Ltd., and Teton Drilling Co. Pty. Ltd., 49%.

Western Mining Ltd. controls the largest uranium reserve in South Australia at its Roxby Downs deposit, located 500 kilometers north of Adelaide. The deposit contains low-grade uranium, estimated at between 0.02 and 0.07 percent U_3O_8, in association with copper ore (between 0.75 and 2.5 percent copper) and trace gold. Uranium and gold would be recovered at Roxby Downs as a by-product of copper production. The uranium mineralization occurs in at least three zones within a sequence of black shale and carbonate sediments of Middle Proterozoic Age. The top ore zone is at a depth of 330 meters; the bottom zone is at a depth of more than 600 meters. The deposit presently extends 3,000 meters in an east-west direction, by 2,000 meters in a north-south direction, although its limits have not yet been defined.

It has been estimated that exploratory drilling could continue for up to ten years before a property development program is initiated. Roxby Downs represents the largest mineral deposit to be discovered in Australia in recent years. Ore reserves are estimated to be in the hundreds-of-millions of metric tons.

STATISTICAL DATA

EXCHANGE VALUE—$38.00/lb U_3O_8
Determined as of February 29, 1980

DEFINITION

The Exchange Value is Nuexco's judgment of the price at which transactions for significant quantities of natural uranium concentrates could be concluded as of the last day of the month.

DERIVATION

Nuexco bases the Exchange Value upon:
A. Data from recently completed transactions.
B. Data from pending transactions.
C. Firm bids to buy and firm offers to sell.
D. Prices purchasers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy, and prices sellers have expressed a willingness to accept, but for which Nuexco is not aware of firm offers to sell.

COMMENTS

Nuexco does not consider the following in determining the Exchange Value:
A. The price of uranium delivered or to be delivered under old contracts.
B. The price of uranium delivered in connection with contract renegotiations or other than arm's length transactions.

TRANSACTION VALUE
Determined as of February 29, 1980

$/lb U_3O_8	**Millions of Pounds**	**Number of Transactions**	**Number of Months**
39.30	4.0	12	3

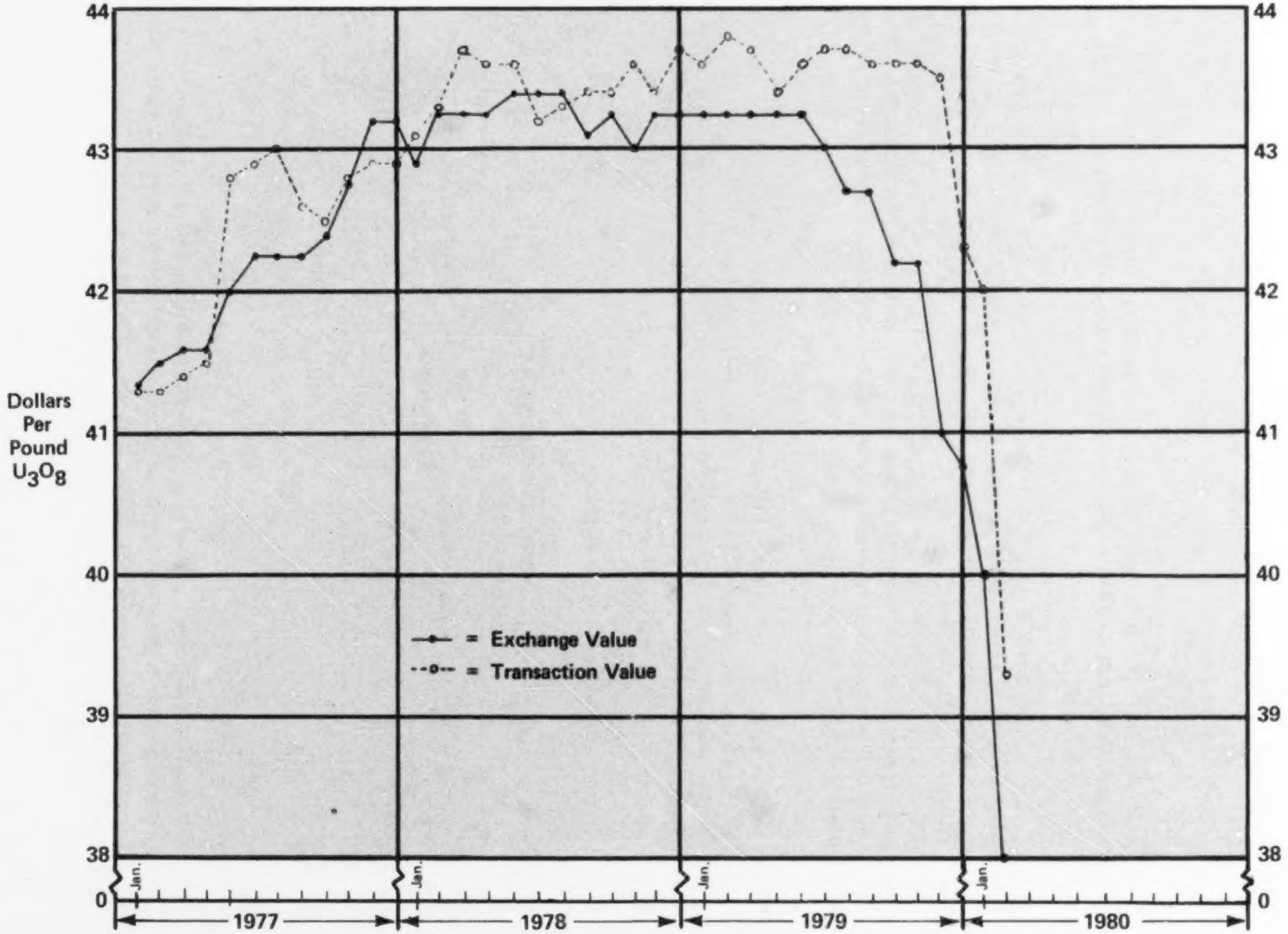
DEFINITION

The Transaction Value is a weighted average price of recent transactions, and is based on prices paid for U_3O_8 in transactions closed within the previous three-month period and for which delivery was scheduled within one year of the transaction date. At least ten transactions totaling at least two million pounds U_3O_8 are included in each calculation, or the sample time is extended as necessary to include these minima. Foreign currencies are converted to US dollars as of the transaction date.

EXCHANGE AND TRANSACTION VALUES SINCE JANUARY 1977

Determined as of the last day of the month indicated

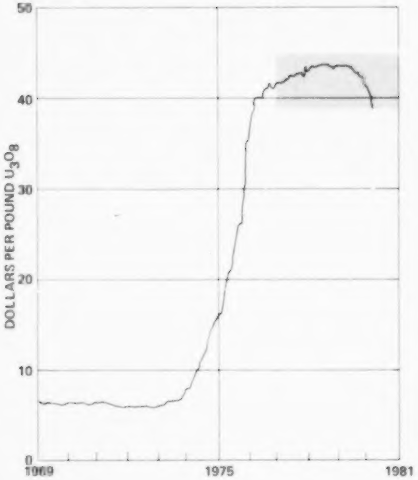
US Dollars/lb. U_3O_8



HISTORICAL EXCHANGE VALUES

Determined as of the last day of the month indicated

US Dollars/lb. U_3O_8



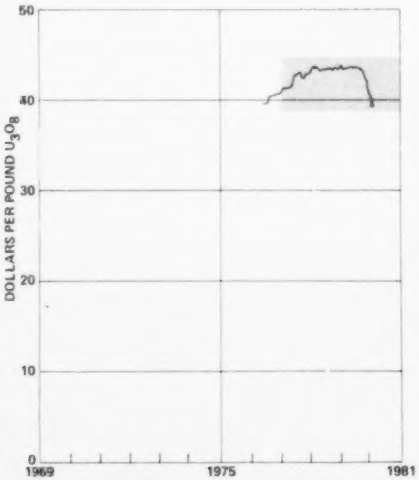
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1968	–	–	–	–	–	–	–	6.35	6.35	6.40	6.45	6.50
1969	–	6.35	6.10	6.10	6.25	6.25	6.20	6.20	6.15	6.15	6.15	6.20
1970	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.20	6.15	6.15	6.15	6.15
1971	6.20	6.20	6.20	6.20	6.15	6.05	6.00	5.95	5.95	5.95	5.95	5.95
1972	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95
1973	5.95	6.00	6.10	6.20	6.45	6.50	6.50	6.50	6.50	6.50	6.75	7.00
1974	7.70	7.90	8.00	9.00	9.50	10.50	11.50	12.00	12.50	14.00	14.75	15.00
1975	16.00	16.00	18.00	20.00	21.00	23.00	24.70	26.00	26.00	28.50	30.00	35.00
1976	35.20	37.00	39.25	40.00	40.00	40.00	40.00	40.40	41.00	41.00	41.50	41.00
1977	41.35	41.50	41.60	41.60	42.00	42.25	42.25	42.25	42.40	42.75	43.20	43.20
1978	42.90	43.25	43.25	43.25	43.40	43.40	43.40	43.10	43.25	43.00	43.25	43.25
1979	43.25	43.25	43.25	43.25	43.25	43.00	42.70	42.70	42.20	42.20	41.00	40.75
1980	40.00	38.00										

Note: See earlier Nuexco Reports for evolution of the definition of Exchange Value.

HISTORICAL TRANSACTION VALUES

Determined as of the last day of the month indicated

US Dollars/lb. U_3O_8



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1976	–	–	–	–	39.60	39.70	39.70	40.40	40.30	40.60	40.70	40.70
1977	41.30	41.30	41.40	41.50	42.80	42.90	43.00	42.60	42.50	42.80	42.90	42.90
1978	43.10	43.30	43.70	43.60	43.60	43.20	43.30	43.40	43.40	43.60	43.40	43.70
1979	43.60	43.80	43.70	43.40	43.60	43.70	43.70	43.60	43.60	43.60	43.50	42.30
1980	42.00	39.30										

STATISTICAL DATA

EXCHANGE VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES*

Country	per lb U_3O_8 in Concentrates	per kg U_3O_8 in Concentrates	per kg U in Concentrates
US (dollar)	38.00	83.78	98.79
France (franc)	156.81	345.71	407.67
FRG (mark)	66.89	147.47	173.90
Japan (yen)	9,431	20,791	24,518
Switzerland (franc)	63.42	139.82	164.88
UK (pound)	16.63	36.66	43.23
Australia (dollar)	34.55	76.17	89.82
Canada (dollar)	43.50	95.90	113.09
Niger, Gabon (CFA)	7,841	17,285	20,384
South Africa (rand)	30.67	67.62	79.74

* Calculated using currency exchange rates published in the Wall Street Journal on the last business day of the month.

LOAN USE CHARGE RATE — 7.0%/year

DEFINITION

The Loan Use Charge Rate is Nuexco's judgment of the annual interest rate at which uranium loans could be concluded as of the last day of the month.

DERIVATION

Nuexco bases the Loan Use Charge Rate upon:

A. Data from recently completed or pending loan transactions.
B. Rates included in firm proposals to borrow or lend.
C. Rates that potential borrowers and lenders have expressed a willingness to pay or accept, but for which Nuexco is not aware of firm proposals.

STATISTICAL DATA

CURRENT TRANSACTIONS*

Ref	Delivery Period	Approximate Quantity	Approximate Price as % of Current E.V.	Seller Group	Buyer Group	Remarks
1040	80's	4,000,000 to 7,000,000 lbs U_3O_8	–	Africa	Europe	Price related to market at time of delivery
1044	80	100,000 to 300,000 lbs U_3O_8	103	US	US	
1047	80	100,000 to 300,000 lbs U_3O_8	–	Canada	Europe	Price related to market at time of delivery
1048	80	100,000 to 300,000 lbs U_3O_8	–	Canada	Canada	Price related to market at time of delivery
1051	80	300,000 to 600,000 lbs U_3O_8	101	US	Europe	
1052	80-81	1,000,000 to 2,000,000 lbs U_3O_8	111	Africa	Europe	
1052A	82-86	4,000,000 to 7,000,000 lbs U_3O_8	–	Africa	Europe	Price related to market at time of delivery
1054	80	100,000 to 300,000 lbs U_3O_8	100	US	US	
1055	80	100,000 to 300,000 lbs U_3O_8	92	Europe	US	Enriched UF_6
1059	80	100,000 to 300,000 lbs U_3O_8	–	US	US	Price related to market at time of delivery
1060	80	300,000 to 600,000 lbs U_3O_8	94	US	US	
1062	80	300,000 to 600,000 lbs U_3O_8	99	US	US	
1063	80	100,000 to 300,000 lbs U_3O_8	99	US	US	

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* Transactions listed include not only those in which Nuexco was involved, but also all others of which Nuexco is aware.

STATISTICAL DATA

US GOVERNMENT STATISTICS

	Producer Price Index—Industrial Commodities (1967 = 100) (1)	Consumer Price Index (1967 = 100) (2)	GNP Implicit Price Deflator (1972 = 100) (3)	Gross Average Hourly Earnings of Production or Non-supervisory Workers (US$) (4)		
				Metal Mining (SIC 10)	**Primary Non-ferrous Metals (SIC 333)**	**Chemicals and Allied Products (SIC 28)**
Annual Avg. 1970 (5)	110.0	116.3	91.36	3.88	3.87	3.69
Annual Avg. 1971 (5)	114.0	121.3	96.02	4.12	4.15	3.94
Annual Avg. 1972 (5)	117.9	125.3	100.00	4.49	4.59	4.21
Annual Avg. 1973 (5)	125.9	133.1	105.80	4.82	4.98	4.48
Annual Avg. 1974 (5)	153.8	147.7	116.02	5.43	5.63	4.85
Annual Avg. 1975 (5)	171.5	161.2	127.15	6.13	6.24	5.37
Annual Avg. 1976 (5)	182.3	170.5	133.71	6.75	6.87	5.89
Annual Avg. 1977 (5)	195.1 (4)	181.5	141.70	7.28	7.67	6.43
Annual Avg. 1978 (5)	209.4	195.4	152.05	8.23	8.56	7.01
Nov 1978	216.0	202.0	–	8.71	8.87	7.22
Dec 1978	217.2	202.9	156.68	8.72	8.97	7.28
Jan 1979	220.0	204.7	–	8.71	9.01	7.32
Feb 1979	222.5	207.1	–	8.81	9.02	7.32
Mar 1979	225.4	209.1	160.22	8.84	9.11	7.36
Apr 1979	229.0	211.5	–	9.03	9.49	7.50
May 1979	231.6	214.1	–	9.06	9.15	7.47
Jun 1979	234.0	216.6	163.81	9.09	9.44	7.53
Jul 1979	237.5	218.9	–	9.32	9.57	7.60
Aug 1979	240.6	221.1	–	9.38	9.70	7.65
Sep 1979	244.2R	223.4	167.20	9.63	9.79	7.73
Oct 1979	248.5	225.4	–	9.67	9.87	7.82
Nov 1979	250.2	227.5	–	9.79	9.86	7.87
Dec 1979	252.8	229.9	–	9.76P	9.91P	7.89P
Jan 1980	260.3	233.2	–	–	–	7.95P

P = Preliminary R = Revised

(1) US Bureau of Labor Statistics, Washington, D.C.; "Producer Prices and Price Indexes," Table 6 (formerly "Wholesale Prices and Price Indexes"). Producer Price Indexes are revised four months after they are first released to reflect the availability of late reports and corrections by respondents.

(2) US Bureau of Labor Statistics, Washington, D.C.; Consumer Price Index for All Urban Consumers, US City Average, All Items.

(3) US Department of Commerce, Washington, D.C.; Bureau of Economic Analysis, National Income and Wealth Division; "Survey of Current Business," Table A. The GNP Implicit Price Deflator is published quarterly, and seasonally adjusted.

(4) US Bureau of Labor Statistics, Washington, D.C.; "Employment and Earnings," Table C-2. All data based on 1972 revision of SIC Manual. Data for 1970-1976 are adjusted to the March 1977 benchmark. All data for 1977 and beyond are adjusted to the most recent benchmark – March 1978 – and are subject to revision from that point forward with the advent of the next benchmark scheduled for publication in late 1980.

(5) Data for these years, monthly except for the GNP Implicit Price Deflator, appear on pages 4.6 through 4.8 of Report No. 139, dated March 1980.

STATISTICAL DATA

US GOVERNMENT STATISTICS

Producer Price Index – Industrial Commodities
(1967 = 100)[1]

	1978	1977	1976	1975	1974	1973	1972	1971	1970
January	201.6	188.4	177.4	167.5	135.3	120.0	115.9	112.2	108.3
February	202.9	190.0	178.1	168.4	138.2	121.3	116.5	112.5	108.6
March	204.1	191.7	179.0	168.9	142.4	122.8	116.8	113.0	108.8
April	206.1	193.3	180.1	169.7	146.6	124.2	117.3	113.4	109.3
May	207.4	194.2	180.5	170.3	150.5	125.3	117.6	113.8	109.6
June	208.7	194.7	181.5	170.7	153.6	126.0	117.9	114.0	109.9
July	210.1	195.9	182.7	171.2	157.8	126.1	118.1	114.6	110.1
August	211.4	196.9	183.8	172.2	161.6	126.7	118.5	115.3	110.2
September	212.5	197.8	184.8	173.1	162.9	127.4	118.7	115.1	110.4
October	214.7	199.1	186.3	174.7	164.8	128.5	118.8	115.1	111.2
November	216.0	199.3	187.1	175.4	165.8	130.1	119.1	115.0	111.3
December	217.2	200.0	187.4	176.1	166.1	132.2	119.4	115.5	111.7
Annual Average	**209.4**	**195.1**	**182.4**	**171.5**	**153.8**	**125.9**	**117.9**	**114.1**	**110.0**

(1) US Bureau of Labor Statistics, Washington, D.C.; "Producer Prices and Price Indexes," Table 6 (formerly "Wholesale Prices and Price Indexes").

Consumer Price Index – Urban Consumers
(1967 = 100)[2]

	1978	1977	1976	1975	1974	1973	1972	1971	1970
January	187.2	175.3	166.7	156.1	139.7	127.7	123.2	119.2	113.3
February	188.4	177.1	167.1	157.2	141.5	128.6	123.8	119.4	113.9
March	189.8	178.2	167.5	157.8	141.1	129.8	124.0	119.8	114.5
April	191.5	179.6	168.2	158.6	143.9	130.7	124.3	120.2	115.2
May	193.3	180.6	169.2	159.3	145.5	131.5	124.7	120.8	115.7
June	195.3	181.8	170.1	160.6	146.9	132.4	125.0	121.5	116.3
July	196.7	182.6	171.1	162.3	148.0	132.7	125.5	121.8	116.7
August	197.8	183.3	171.9	162.8	149.9	135.1	125.7	122.1	116.9
September	199.3	184.0	172.6	163.6	151.7	135.5	126.2	122.2	117.5
October	200.9	184.5	173.3	164.6	153.0	136.6	126.6	122.4	118.1
November	202.0	185.4	173.8	165.6	154.3	137.6	126.9	122.6	118.5
December	202.9	186.1	174.3	166.3	155.4	138.5	127.3	123.1	119.1
Annual Average	**195.4**	**181.5**	**170.5**	**161.2**	**147.7**	**133.1**	**125.3**	**121.3**	**116.3**

(2) US Bureau of Labor Statistics, Washington, D.C.; Consumer Price Index for All Urban Consumers, US City Average, All Items.

STATISTICAL DATA

US GOVERNMENT STATISTICS

GNP Implicit Price Deflator
Quarterly Data (Seasonally Adjusted)
(1972 = 100)(1)

	1978	1977	1976	1975	1974	1973	1972	1971	1970
First Quarter	147.05	138.27	131.47	124.21	111.28	102.89	98.76	94.40	89.81
Second Quarter	150.82	140.86	133.06	125.96	114.34	104.65	99.45	95.73	90.91
Third Quarter	153.45	142.63	134.56	128.28	117.52	106.57	100.29	96.53	91.74
Fourth Quarter	156.68	144.56	136.35	130.17	121.06	109.05	101.44	97.38	92.99
Annual Average	**152.05**	**141.70**	**133.71**	**127.15**	**116.02**	**105.80**	**100.00**	**96.02**	**91.36**

(1) US Department of Commerce, Washington, D.C.; Bureau of Economic Analysis, National Income and Wealth Division; "Survey of Current Business."

Gross Average Hourly Earnings of Production or Non-supervisory Workers (US$)(2) (3)

Metal Mining (SIC 10)

	1978	1977	1976	1975	1974	1973	1972	1971	1970
January	7.73	6.95	6.53	5.90	5.10	4.68	4.46	3.95	3.75
February	7.79	7.02	6.51	5.90	5.12	4.71	4.44	3.93	3.77
March	7.84	7.07	6.55	5.89	5.15	4.71	4.46	3.96	3.77
April	7.97	7.12	6.64	5.93	5.29	4.77	4.49	4.03	3.83
May	8.04	7.19	6.63	6.00	5.29	4.74	4.47	4.03	3.85
June	8.08	7.26	6.67	6.02	5.31	4.75	4.48	4.03	3.88
July	8.25	7.32	6.76	6.11	5.36	4.80	4.59	3.99	3.91
August	8.40	7.37	6.89	6.23	5.53	4.85	4.64	4.30	3.91
September	8.56	7.49	7.00	6.35	5.68	4.98	4.69	4.38	4.01
October	8.60	7.52	6.93	6.38	5.75	4.97	4.65	4.30	3.96
November	8.71	7.63	6.99	6.40	5.80	5.00	4.65	4.28	3.99
December	8.72	7.65	7.00	6.44	5.86	5.02	4.68	4.35	3.96
Annual Average	**8.23**	**7.28**	**6.76**	**6.13**	**5.44**	**4.84**	**4.56**	**4.12**	**3.88**

(2) For 1970 through 1976; US Bureau of Labor Statistics, Washington, D.C.; "Employment and Earnings, United States, 1909-78," Bulletin 1312-11.

(3) For 1977 and 1978; US Bureau of Labor Statistics, Washington, D.C.; "Employment and Earnings Supplement, Revised Establishment Data, November 1979."

STATISTICAL DATA

US GOVERNMENT STATISTICS

Gross Average Hourly Earnings of Production or Non-supervisory Workers (US$) (1) (2)

Primary Non-ferrous Metals (SIC 333)

	1978	1977	1976	1975	1974	1973	1972	1971	1970
January	8.24	7.16	6.54	5.97	5.21	4.79	4.47	3.95	3.78
February	8.28	7.20	6.52	5.96	5.31	4.79	4.45	3.95	3.77
March	8.27	7.24	6.64	6.04	5.43	4.83	4.46	3.95	3.76
April	8.32	7.34	6.74	6.04	5.50	4.82	4.47	3.96	3.80
May	8.36	7.37	6.71	6.07	5.49	4.85	4.47	3.98	3.83
June	8.56	7.71	6.82	6.25	5.59	4.96	4.57	4.15	3.88
July	8.62	7.83	6.91	6.34	5.68	5.03	4.63	4.32	3.94
August	8.66	7.78	6.96	6.40	5.76	5.04	4.65	4.35	3.92
September	8.74	8.01	7.07	6.49	5.83	5.10	4.69	4.34	3.98
October	8.84	8.07	7.10	6.53	5.86	5.12	4.68	4.28	3.90
November	8.87	8.12	7.18	6.52	5.87	5.15	4.73	4.29	3.92
December	8.97	8.15	7.18	6.44	5.93	5.22	4.77	4.40	3.95
Annual Average	**8.56**	**7.67**	**6.87**	**6.24**	**5.63**	**4.98**	**4.59**	**4.15**	**3.87**

Chemicals and Allied Products (SIC 28)

	1978	1977	1976	1975	1974	1973	1972	1971	1970
January	6.78	6.19	5.68	5.17	4.67	4.41	4.15	3.84	3.60
February	6.82	6.20	5.71	5.18	4.68	4.40	4.17	3.85	3.60
March	6.84	6.23	5.72	5.21	4.69	4.40	4.17	3.85	3.60
April	6.87	6.30	5.80	5.24	4.75	4.44	4.18	3.90	3.62
May	6.94	6.33	5.82	5.31	4.76	4.46	4.22	3.92	3.64
June	6.96	6.39	5.87	5.37	4.82	4.49	4.25	3.96	3.68
July	7.05	6.47	5.95	5.43	4.91	4.53	4.28	4.02	3.71
August	7.06	6.49	5.96	5.46	4.94	4.54	4.29	4.02	3.73
September	7.13	6.57	6.05	5.51	5.01	4.57	4.35	4.06	3.78
October	7.19	6.62	6.07	5.53	5.04	4.59	4.34	4.04	3.77
November	7.22	6.66	6.11	5.59	5.10	4.62	4.34	4.04	3.79
December	7.28	6.73	6.16	5.63	5.15	4.64	4.38	4.11	3.81
Annual Average	**7.01**	**6.43**	**5.91**	**5.39**	**4.88**	**4.51**	**4.26**	**3.97**	**3.69**

(1) For 1970 through 1976; US Bureau of Labor Statisics, Washington, D.C.; "Employment and Earnings, United States, 1909-1978," Bulletin 1312-11.

(2) For 1977 and 1978, US Bureau of Labor Statistics, Washington, D.C.; "Employment and Earnings Supplment, Revised Establishment Data, November 1979."

STATISTICAL DATA

CANADIAN GOVERNMENT STATISTICS

	Industry Selling Price Index: Manufacturing (D 500000) (1), (2) (1971 = 100.0)	Wage-earner Data: Average Hourly Earnings ($C) (3), (4)		
		Metal Mining, including milling (SIC 050-059)	**Primary Metal Industries, non-ferrous (SIC 296-298)**	**Chemicals and Chemical Products (SIC 370-379)**
Annual Avg. 1977	174.3	8.18	6.50	6.51
Annual Avg. 1978	190.4	8.76	6.82	6.97
Oct 1978	197.6	9.20	7.04	7.13
Nov 1978	198.6	9.18	7.09	7.14
Dec 1978	199.4	9.29	6.93	7.14
Jan 1979	204.8	9.19	7.14	7.29
Feb 1979	208.5	9.24	7.18	7.36
Mar 1979	210.4	9.47	7.20	7.51
Apr 1979	212.8	9.68	7.26	7.63
May 1979	214.5	9.65	7.28	7.61
Jun 1979	216.0	9.49	7.27	7.66
Jul 1979	218.3R	9.37	7.34	7.73
Aug 1979	220.0R	9.56	7.38	7.77
Sep 1979	223.4R	9.75	7.50	7.81
Oct 1979	227.2R	10.03	7.54	7.88
Nov 1979	228.1R	10.13P	7.62P	7.90P
Dec 1979	230.1P			

P = Preliminary
R = Revised

(1) Statistics Canada, Prices Division, Ottawa; "Industry Price Indexes" (Catalogue 62-011), Table 1. Indexes for the most recent six months shown are subject to revision.

(2) Monthly data for 1973 through 1978 appear on page 4.10 of Report No. 138, dated January 31, 1980.

(3) Statistics Canada, Labour Division, Employment and Payrolls Section, Ottawa; "Employment, Earnings and Hours" (Catalogue 72-002), Table 2.

(4) Monthly data for 1977 and 1978 appear on page 4.11 of Report No. 138, dated January 31, 1980.

STATISTICAL DATA

AUSTRALIAN GOVERNMENT STATISTICS

	Price Index of Materials Used in Manufacturing Industry – All Groups (Year 1968-69 = 100.0)(1)	Weighted Average Minimum Weekly Wage Rates – Adult Males Australia Mining and Quarrying (A$)(2)
Annual Avg. 1970(3)	101.4	59.88
Annual Avg. 1971(3)	101.5	65.95
Annual Avg. 1972(3)	105.6	71.26
Annual Avg. 1973(3)	124.4	78.96
Annual Avg. 1974(3)	141.9	108.07
Annual Avg. 1975(3)	150.4	132.55
Annual Avg. 1976(3)	168.4	160.93
Annual Avg. 1977(3)	192.0	179.03
Annual Avg. 1978(3)	215.4	190.04
Sep 1978	228.1	190.26
Oct 1978	230.3	190.56
Nov 1978	232.2	190.86
Dec 1978	235.7	199.27
Jan 1979	246.3	199.76
Feb 1979	253.0	200.00
Mar 1979	264.0	201.44
Apr 1979	273.0	202.27
May 1979	287.5	203.37
Jun 1979	293.8	209.87
Jul 1979	295.8	210.48
Aug 1979	290.8	211.56
Sep 1979	300.0	212.33
Oct 1979	307.0	211.86
Nov 1979	308.0P	
Dec 1979	317.0P	

P = Preliminary
R = Revised

(1) Australian Bureau of Statistics, Canberra; "Price Index of Materials Used in Manufacturing Industry" (Catalogue No. 6411.0), Table 3.

(2) Australian Bureau of Statistics, Canberra, "Wage Rates, Australia" (Catalogue No. 6312.0), Table 1. Figures for the latest twelve months shown are subject to revision.

(3) Monthly data for 1970 through 1978 appear on pages 4.7 and 4.8 of Report No. 138, dated January 31, 1980.

MARKET OPPORTUNITIES

Market Opportunities are *active* inquiries in the uranium market to buy, sell, borrow or lend. The data presented in this section are in no way intended to be indicative of the entire uranium market for the time period covered.

SUPPLY

Nuexco Reference Number	**Thousands of Pounds U_3O_8**				**Remarks**
	1980	**1981**	**1982**	**1983**	
Uranium Available for Sale:					
1236	200	200	200		
1274	150	300	300		
1284	250				
1285	500				
1286	500	150	150	150	
1306		100	200	200	
1315			200	200	
1324		500	500	500	
1325	800				
1333	500	250	250		
1338	250				
1345	50				
1346	300				
1358	25				
1377	50				
1378	400				UF_6
TOTAL	4075	1500	1800	1050	
Uranium Available for Loan:					
1136	2000				UF_6
1175	725				UF_6
1234	700				
1239	1000				UF_6
1354	600				
1355	600				
TOTAL	5625				

MARKET OPPORTUNITIES

DEMAND

Nuexco Reference Number	Thousands of Pounds U_3O_8				Remarks
	1980	1981	1982	1983	
Inquiries to Purchase:					
1146			300		
1227			300	300	
1260		800			
1321			400	400	
1322				250	
1335	500				
1357		300			
TOTAL	500	1100	1000	950	
Inquiries to Borrow:					
1034	800				
1120	500				
1121	500				
1220	1000				
1240	1000				
1308	200				
1348	500				
TOTAL	4500				

NUEXCO
NUCLEAR EXCHANGE CORPORATION

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A. PAYNE KIBBE	Chairman
J. ROBERT WOLCOTT	President
MATHIAS M. KLINGLER	Chief Financial Officer
GEORGE WHITE, JR.	Senior Vice President
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ERRATA

There was an error in Table A, page 1.0, of Report No. 139. Production in Canada during 1979 should have been 17.5 million pounds U_3O_8, not 15.0 million pounds. The corrected table is shown below.

Table A

ESTIMATED WORLD URANIUM PRODUCTION
(millions of pounds U_3O_8)

	1978	**1979**
United States	37.0	37.0
Canada	17.5	17.5
Republic of South Africa	10.3	12.5
Other Africa	15.0	22.0
Other nations*	7.2	9.5
TOTAL	87.0	98.5

*Does not include Communist areas.

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NUEXCO

MONTHLY REPORT
ON THE URANIUM MARKET

NO. 140
APRIL 1980

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EXECUTIVE SUMMARY & INDUSTRY OVERVIEW
NUEXCO REPORT NO. 140

The **Exchange Value** decreased again this month from $38.00 to $35.00 per pound U_3O_8. There has been a general absence of utility buyers from the market, due primarily to the existence of large inventories. US and worldwide inventories average about two-and-one-half to three years forward consumption High interest rates in the US have made uranium inventories expensive to hold. Thus no US utilities are known to be intentionally adding to inventories, and some are attempting to reduce inventories by offering material for sale on the near-term market. The only potential buyers currently in the market are producers, which might buy on the near-term market to deliver under existing contracts, rather than produce the material themselves. The economic limitations involved in such make-or-buy decisions have put additional downward pressure on an already declining market.

Nuexco has recomputed its estimates of **Apparent Future Consumption**. Estimated worldwide cumulative consumption from 1979 through 1990 is down by approximately ten percent from Nuexco's last published estimate (Report 132, July 31, 1979). Estimated cumulative consumption for the **US** during the same period also declined by about ten percent. Licensing delays and plant cancellations are primarily responsible for the decrease in the US. Estimated consumption for **Japan** declined considerably, due mainly to changes in Nuexco's computational groundrules regarding planned capacity additions and capacity factors for Japan. *Consumption* is defined by Nuexco as having occurred when natural uranium enters the nuclear fuel enrichment-fabrication pipeline, for ultimate use in a reactor.

In **Sweden**, more than 58 percent of the voters in the March 23 nuclear referendum endorsed the continued use of nuclear power. Two new nuclear units will start up in Sweden this year, in addition to the six already operating.

In **Australia**, Queensland Mines has completed construction of its Nabarlek production center. Metallurgical testing is now underway, and production is expected to begin later this year. Photographs of the Nabarlek site are included in this Report.

This month's *Topical Essay* is the sixth in a series on various aspects of uranium marketing and procurement. It focuses on delivery and payment provisions in uranium supply contracts.

The *Raw Materials* section begins a two-part series on uranium occurrence in quartz-pebble conglomerates.

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NUEXCO

MONTHLY REPORT ON THE URANIUM MARKET

No. 140 April 1980

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FOREWORD ii

THE URANIUM MARKET

PUBLIC AND GOVERNMENT POLICY 1.0
GENERAL 1.0
  Estimates of Apparent Future Consumption 1.0
  Statistical Data 1.4
AFRICA 1.5
AUSTRALIA 1.5
FAR EAST 1.5
UNITED STATES 1.8
PRICING 1.8

TOPICAL ESSAY

MARKETING AND PROCUREMENT: DELIVERY AND PAYMENT 2.0

RAW MATERIALS

QUARTZ-PEBBLE CONGLOMERATES—PART I 3.0

STATISTICAL DATA

EXCHANGE AND TRANSACTION VALUES 4.0
LOAN USE CHARGE RATE 4.3
CURRENT TRANSACTIONS 4.4
GOVERNMENT STATISTICS 4.5

MARKET OPPORTUNITIES

SUPPLY 5.0
  Uranium Available for Sale
  Uranium Available for Loan
DEMAND 5.1
  Inquiries to Purchase Uranium
  Inquiries to Borrow Uranium

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FOREWORD

We are delighted to announce that Mr. W. Hardy Prentice has joined Nuexco as a Representative, serving the north-central United States. Hardy was with the General Electric Company for more than forty years, until his retirement in 1977. Most recently he was a Regional Manager in the Electric Utility Sales Division. He is a graduate of Kansas State University and is a Registered Professional Engineer. Hardy now lives in Cleveland, Ohio.

Enclosed with this Report is a copy of a talk by George White, Jr. delivered on March 5, 1980 at the Dain Bosworth Institutional Investors Conference at Vail, Colorado.

URANIUM MARKET

PUBLIC AND GOVERNMENT POLICY

More than 58 percent of the vote in the **Swedish referendum** of March 23 was pro-nuclear. About 38.5 percent was against nuclear power. The remaining votes cast were blank. Although the vote is not officially binding, the government previously stated it will consider it binding. Thus the six units presently operating will continue to operate. Also, the government has approved the resumption of startup activities at the 900 MW Ringhals unit 3, a PWR, and the 900 MW Forsmark unit 1, a BWR. These units are expected to be in service this year. The government is also expected to allow work to continue on Ringhals unit 4 and Forsmark unit 2. Work is also expected to begin soon on the final two nuclear units referenced in the referendum.

In the **UK**, the Protection of Trade Interests Bill has been approved by the House of Lords, and is now law. Under this legislation—designed in part to counteract the US antitrust actions in the uranium industry—the punitive portion of multiple judgment awards (e.g. two-thirds of a treble damage award in a civil suit brought under US antitrust law) will not be recoverable in Britain. It also permits British companies to recover in British courts any multiple damages paid under a judgment in a US or other foreign court. A bill similar to the British legislation has been introduced into committee in the House of Commons of **Australia**.

The most recent estimates indicate that **Belgium** will be bringing one new nuclear unit on line in each of the four years 1981 through 1984. (Doel 3 and 4 in 81 and 83, Tihange 2 and 3 in 82 and 84). If this schedule is achieved, it is expected that about 50 percent of Belgium's electric production will be supplied by nuclear power by the end of 1984.

GENERAL

Estimates of Apparent Future Consumption

In Report 132, dated July 31, 1979, Nuexco presented revised estimates of Apparent Future Consumption of U_3O_8. Subsequent events warrant revising those estimates once again. Table 1 presents Nuexco's estimates of Apparent Future Consumption as of March 31, 1980. (The term *consumption* as used by Nuexco refers to U_3O_8 entering the enrichment-fabrication pipeline.) The corresponding installed nuclear generating capacities are shown in Table 2.

US. The US has undergone some dramatic changes in the past eight months. Reaction to the accident at Three Mile Island, regulatory problems, double-digit inflation, soaring interest rates, and reduced projections of utility load growth have contributed to numerous cancellations, deferrals or delays of nuclear power plants. Although Nuexco's current estimates represent a cumulative reduction (since the last Nuexco estimate, July 31, 1979) of more than 50,000,000 pounds U_3O_8 in US consumption through 1990, further reductions can still be expected.

The maximum anticipated level of US consumption during the 1980's is also lower than previous estimates. Table 1 indicates a maximum US consumption level of about 50,000,000 pounds U_3O_8 per year, and this level is not reached until 1988. The 1979 US consumption level of 24,800,000 pounds U_3O_8 is a revised figure based on 1979 operating experience. This is a reduction of 3,800,000 pounds U_3O_8 from Nuexco's July 31, 1979 estimate. The current consumption estimate for 1980 is 3,100,000 pounds U_3O_8 lower than the previous estimate. These reductions serve to further exacerbate the current uranium market imbalance, discussed in more detail in the Pricing Section of this Report.

Table 1 indicates a large jump in annual US Apparent Future Consumption after 1980. This is based on the anticipated startup in 1983 of twelve reactors now under construction. That number of new licenses will very likely overload the US NRC's capacity for licensing review. Furthermore, the estimate includes startup during 1980 of almost all of the 14 reactors which were nearly ready to begin operation as of the end of the US NRC licensing moratorium which ended in February, 1980. It is highly unlikely that all of those reactors can begin commercial operation on schedule. Under current conditions in the NRC, it is likely that no more than six to eight US reactors can be licensed in a given year. Therefore about half of the anticipated 1980 startups will very likely be delayed to 1981. Likewise, many anticipated 1981 startups will be delayed to 1982, 1982 startups to 1983 or 1984, and so on. Under this scenario, additional startup delays of forty reactor-years or more are likely. Such a situation would further reduce cumulative Apparent Future Consumption (i.e. fundamental US demand)

Table 1: APPARENT FUTURE CONSUMPTION[a]

(Annual, Millions of Pounds U_3O_8 equivalent)

BUYER GROUP	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
United States:												
Reactors Now Operational	16.3	17.6	17.7	17.4	17.9	18.2	18.4	17.8	18.3	18.4	18.3	17.8
Now under Construction	8.5	10.9	19.7	22.5	24.6	23.6	23.1	25.3	25.5	25.5	25.2	25.2
Now on Order	0	0	0	0	2.0	2.4	4.8	4.4	4.3	5.6	7.8	7.3
US Subtotal	24.8	28.5	37.4	39.9	44.4	44.2	46.4	47.5	48.1	49.6	51.3	50.3
Europe:												
Reactors Now Operational	12.8	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4
Now Under Construction	22.0	15.2	23.1	22.6	21.7	22.0	21.6	20.7	21.0	21.0	21.0	21.0
Now on Order	0	0	0	0.9	5.1	6.4	8.3	6.1	6.3	6.7	6.7	6.7
Europe Subtotal	34.8	29.6	37.5	37.9	41.2	42.8	44.3	41.2	41.7	42.1	42.1	42.1
Far East[b]:												
Reactors Now Operational	4.6	4.6	4.6	4.6	4.6	4.7	4.7	4.7	4.7	4.7	4.7	4.7
Now under Construction	1.5	3.1	3.0	5.6	4.1	4.6	5.4	4.8	4.8	4.8	4.8	4.8
Now on Order	0	0	0.7	1.8	3.5	2.2	2.9	2.9	2.3	2.7	2.7	2.7
Far East Subtotal	6.1	7.8	8.3	12.1	12.2	11.5	13.1	12.4	11.8	12.3	12.3	12.3
Other Free World[c]:												
Reactors Now Operational	2.3	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
Now under Construction	0.7	1.5	2.7	4.3	3.5	5.0	4.1	4.4	4.4	4.4	4.4	4.4
Now on Order	0	0	0	0	0	1.5	1.9	1.2	1.9	1.9	1.8	2.1
Other Subtotal	3.0	3.7	4.9	6.5	5.7	8.7	8.2	7.9	8.5	8.5	8.5	8.8
FREE WORLD[c] TOTAL[d]	68.7	69.6	88.1	96.4	103.5	107.2	112.0	109.0	110.1	112.5	114.2	113.5
WORLDWIDE BREAKDOWN BY STATUS:												
Reactors Now Operational	36.0	38.8	38.9	38.6	39.1	39.5	39.7	39.1	39.6	39.7	39.6	39.1
Now under Construction	32.7	30.7	48.5	55.0	53.9	55.2	54.2	55.2	55.7	55.7	55.4	55.4
Now on Order	0	0	0.7	2.7	10.6	12.5	17.9	14.6	14.8	16.9	19.0	18.8

NOTES:

a. Computed quantites of U_3O_8 which would be used under the given conditions, to fabricate fuel for loading and reloading reactors operating, under construction or on order. Compiled and computed on a reactor-by-reactor basis, quantities for each reactor are based on specific core characteristics, 0.20% tails assay, no recycling, 24-month lead time for procuring first cores and 18-month lead time for procuring each reload. Assumes reloads occur one year after commercial operating date and annually thereafter. 1979 figures reflect actual capacity factor achieved by each reactor. Estimates for 1980-1990 use Nuexco estimates of individual reactor capacity factor.

b. Japan, Korea, Philippines, Taiwan.

c. Excludes Bulgaria, Czechoslovakia, German Democratic Republic, Finland (2 Russian reactors), Hungary, Poland, Romania, USSR.

d. Differences up to 0.2 millions lbs U_3O_8 are due to round-off error.

Table 2: INSTALLED NUCLEAR CAPACITY x 1000 MWe (net)[a]

BUYER GROUP	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
United States:												
Reactors Now Operational	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0
Now under Construction	0	10.9	18.0	24.5	36.0	48.5	59.7	66.3	72.4	74.8	77.1	78.4
Now on Order	0	0	0	0	0	0	2.3	4.7	8.2	11.5	12.6	15.6
US Subtotal	50.0	60.9	68.0	74.4	86.0	98.5	111.9	121.0	130.7	136.3	139.7	143.9
Europe:												
Reactors Now Operational	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3
Now under Construction	0	8.5	27.0	36.2	48.0	55.9	58.5	60.5	61.5	61.5	61.5	61.5
Now on Order	0	0	0	0	0	0.9	6.9	13.1	18.9	20.0	21.3	21.3
Europe Subtotal	36.3	44.9	63.3	72.5	84.3	93.1	101.7	109.9	116.7	117.9	119.1	119.1
Far East[b]:												
Reactors Now Operational	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3
Now under Construction	0	0	1.5	4.7	6.3	10.6	12.4	13.3	14.3	14.3	14.3	14.3
Now on Order	0	0	0	0	0.8	2.7	5.7	6.8	7.8	8.7	8.7	8.7
Far East Subtotal	16.3	16.3	17.8	20.9	23.5	29.6	34.4	36.4	38.3	39.3	39.3	39.3
Other Free World[c]:												
Reactors Now Operational	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5
Now under Construction	0	1.0	2.3	3.7	6.1	9.7	10.3	12.3	13.1	13.1	13.1	13.1
Now on Order	0	0	0	0	0	0	0	0.6	3.3	4.3	5.1	6.0
Other Subtotal	6.5	7.6	8.8	10.2	12.6	16.2	16.8	19.4	22.9	23.8	24.7	25.6
FREE WORLD[c] TOTAL[d]	109.1	129.7	157.9	178.0	206.4	237.4	264.8	286.7	308.6	317.3	322.8	327.9
WORLDWIDE BREAKDOWN BY STATUS:												
Reactors Now Operational	109.1	109.1	109.1	109.1	109.1	109.1	109.1	109.1	109.1	109.1	109.1	109.1
Now under Construction	0	20.4	48.8	68.9	96.5	124.7	140.8	152.4	161.3	163.7	166.0	167.2
Now on Order	0	0	0	0	0.8	3.6	14.9	25.2	38.2	44.5	47.7	51.6

NOTES:

a. Uses Nuexco estimates of commercial operating dates.

b. Japan, Korea, Philippines, Taiwan.

c. Excludes Bulgaria, Czechoslovakia, German Democratic Republic, Finland (2 Russian reactors), Hungary, Pland, Romania, USSR.

d. Differences up to 200 MWe are due to round-off error.

by fifteen million pounds U_3O_8 or more through 1990.

The total of 50,000 MWe (net) in Table 2 under the classification of *Reactors Now Operational* in the US is based on 69 reactors. Shippingport and Hanford were not included. Arkansas Nuclear unit 2 was not included in the *Reactors Now Operational* category because it has not yet been declared commercial. Sequoyah unit 1 was not included because its license is for startup testing only. Requirements for both these reactors were included under the category of *Reactors Now Under Construction*. Included in the 69 reactors were Indian Point unit 1, Humboldt Bay, and TMI unit 2, even though these plants are indefinitely shut down. Requirements estimates in Table 1 for the latter three units would reflect their non-operational status.

Europe. Nuexco's current estimate of Apparent Future Consumption for Europe represents a cumulative reduction of approximately 15,000,000 pounds U_3O_8 in fundamental demand since the last published Nuexco estimate. Some or all of this reduction could well be offset by new reactor orders in the aggressive French nuclear program.

Far East. This market has been relatively quiet in recent months. However, Nuexco's current estimates of Apparent Future Consumption are considerably lower than those published July 31, 1979. These differences are due to two major revisions in Nuexco's procedures for estimating consumption in Japan:

—Substantially reduced estimates of capacity factor;

—Narrower interpretation of the term "on order".

Japan's nuclear regulatory structure is such that it has been difficult for Japanese reactors to average much more than 75 percent availability. As a result, Japan's national average capacity factor was only about 50 percent in 1979. While this situation may change with time, Japanese operating and regulatory practice appears to have been so consistently conservative that Nuexco believes it will continue in that direction. Therefore the current estimate of Apparent Future Consumption for Japan is based on recent operating experience for reactors now operational. For Japanese reactors under construction or on order, a nominal capacity factor of 50 percent was used in this estimate. In prior estimates Nuexco used capacity factors based on expectations of average performance. This change of course results in considerably lower consumption levels.

The second change in Nuexco's procedures for estimating Japanese uranium consumption concerns the treatment of the category of "plants on order." Japan is unusual in that there are no reactors currently on order scheduled for startup later than 1986, although present plans call for substantial additions to nuclear generating capacity after that year. Sites have been selected for other plants, but formal orders have not yet been placed. In prior estimates, Nuexco included such planned reactors in its consumption forecasts for Japan, even though planned—but not ordered—reactors were not included elsewhere in the world. The current estimate reverses this position, and only reactors now operational, under construction, or on order are included. Thus the estimate of fundamental Japanese demand in this Report is considerably lower than previous Nuexco estimates.

Methodology. In order to facilitate interpretation of the results presented, the methodology used in developing the concept of Apparent Future Consumption, first published in Nuexco Report 128, is repeated here in condensed form:

1. Estimates of Apparent Future Consumption are not forecasts of uranium demand. Rather, these estimates comprise a portion of uranium demand. As indicators of the amount of uranium needed to fuel the reactors under consideration, these estimates should be regarded as relatively hard demand in the sense that this portion of demand is quite insensitive to uranium prices. Market demand *for the assumed pattern of capacity additions* can be higher, but not likely lower.
2. Components which can cause demand to exceed Apparent Future Consumption are:
   a. Utility buyers plan their procurement strategies to achieve a very high probability of having access to at least enough uranium to meet commitments as they arise;
   b. Accelerated reactor construction schedules can advance the dates of uranium need;
   c. Buyers may elect to purchase uranium in excess of need, simply to enhance security of supply.

3. Apparent Future Consumption is based on information available today subject to frequent revision as the date of consumption draws nearer.
4. Uranium is deemed to have been consumed when it has entered the enrichment-fabrication pipeline for ultimate use in a reactor.
5. Reactor loading was calculated, for each reactor, based on its individual core characteristics. This technique is distinct from the method customarily used in estimating reactor requirements simply as a direct function of installed capacity.
6. The estimates assume that: a. U_3O_8 deliveries for first cores predate commercial operation by two years. b. First reload occurs 12 months after commercial operating date and annually thereafter. c. U_3O_8 delivery for each reload predates reload by 18 months.
7. Using the assumptions listed above, the estmate for a given reactor can be computed as a function of assumed capacity factor, tails assay and commercial operating date.
8. Reactors fueled by the USSR are excluded. Although Soviet bloc reactors account for substantial demand, Soviet participation in uranium trading has been negligible and appears likely to remain so.
9. Actual commercial operating dates can vary widely from published dates. Nuexco uses the best information available, much of it from unpublished sources, to prepare its own estimates of operating dates.
10. These estimates make no provision for orders not yet placed. Only the requirements associated with reactors operating, under construction or on order are included. Consequently, none of these estimates can be compared directly to forecasts of uranium requirements. Rather, these estimates should be regarded as minimum requirements.
11. The analysis period of 12 years was chosen as an arbitrary measure of the longest expected time interval between inception and commercial operation of a nuclear power plant.

Statistical Data

Beginning in this issue, Nuexco will reprint the "Average Declared Working Costs per Metric Ton of Gold Ore Milled" published by the Chamber of Mines of South Africa. It is commonly called the "Chamber of Mines Index." The following discussion defines the term "working costs" and presents a breakdown for a typical gold mine. Capital expenditures are included in working costs only to the extent that they are charged against current expenses rather than capitalized. Taxes and government royalties are not included.

Typical working cost categories used by South African gold mining companies which are members of the Chamber of Mines are as follows:

(1) White labor charges
(2) Non-White labor charges
(3) Occupational diseases levy
(4) Stores and materials
(5) Electric light and power, compressed air and water charges
(6) Outside contractors
(7) Payments to S.A. Government
(8) Payments to provincial and local authorities
(9) Administration
(10) Other

Table 3 contains some examples of working costs since 1939.

Table 3
Chamber of Mines Index
(Rands/ton milled)

Year	**1939**	**1948**	**1957**	**1963**	**1975**
White labor	0.65	0.94	1.64	1.86	4.04
Non-white labor	0.44	0.52	0.80	0.91	4.51
Stores and materials	0.79	1.06	1.85	2.20	5.59
All other costs	0.26	0.34	0.72	0.89	2.62
Total cost per ton	2.14	2.86	5.01	5.86	16.76

As stated in previous Nuexco Reports, the major reason for Nuexco's reprinting statistical data such as the Chamber of Mines Index is to assist Subscribers in assessing changes in uranium production costs, and the effect of such changes on industry viability. Since virtually all of South Africa's uranium is produced in association with gold mining, inferences concerning uranium drawn on the basis of the Chamber of Mines Index should be carefully scrutinized. Most mines still consider uranium a by-product, and the cost of mining and milling the ore is related to gold production. Uranium production is considered separately. In some mines, however, both uranium and gold are required for viability, so mining and milling costs are treated differently from the "by-product" mines. In any event, the gold market should be a primary consideration in any assessment of the South African uranium industry.

Beginning with this Report, Nuexco will also reprint the South African Consumer Price Index. Statistical data for the Republic of South Africa appear on page 4.8 of this Report. Page 4.9 contains detailed historical data for the years 1970 through 1979.

Africa

The outcome of the recent elections in Rhodesia, with the overwhelming success of the Marxist faction, could have a marked effect on stability in southern Africa, and settlement prospects in **Namibia.** The process is once more under way toward a negotiated, internationally accepted settlement in Namibia. Prior to the Rhodesian elections, it was felt that the future independent government of Namibia would favor free-enterprise, given the success of the Democratic Turnhalle Alliance in the previous internal elections there. However the turnabout in Rhodesia in the internationally-accepted independence elections held in March have led to speculation that the same pattern might be followed in Namibia.

The world's largest uranium production facility, Rossing, is located in Namibia. It is currently running at its design rating of about 10,000,000 pounds U_3O_8 annually. Although Rossing's reserves are probably sufficient to warrant expanding its output, the chances of its doing so are very slight, given the political uncertainty in Namibia, combined with the current depressed state of the uranium market. It is also expected that Langer Heinrich will not proceed with production until the political future becomes clearer.

Australia

The negotiation of the structure and details of Energy Resources of Australia (ERA), the company which will own the Ranger deposit, are proving more difficult and time-consuming than originally expected. This is particularly true with respect to the would-be foreign equity holders which are seeking price concessions in consideration of their putting up equity capital. The Australian government has indicated, however, that it will not approve such concessions.

In addition, there is now some speculation that the **UK** will not participate in ERA, and it has been suggested that they are attempting to structure a package involving participation in Roxby Downs and a centrifuge enrichment project in South Australia. **Korea** has been mentioned as a potential new candidate for an equity position. ERA's public share offering must await the final determination of the ownership position of the foreign users.

Construction of the mill at Queensland Mines' Nabarlek deposit is complete and mechanical testing is now underway. This will be followed by water testing and then "commissioning runs" utilizing low grade material (ore containing less than 0.1 percent U_3O_8). Full production is expected by the end of June, 1980. Initial commercial deliveries are scheduled for the third quarter of 1980.

Aerial photographs of the completed Nabarlek plant are shown in Figure 1 and Figure 2. All mining has also been completed, and the ore has been stockpiled adjacent to the mill. The ore contains an estimated 26,500,000 pounds U_3O_8 at an average ore grade of 2.35 percent U_3O_8. The ore stockpile has been spray-coated with a thin layer of concrete to protect it from the weather. The mine pit is shown in Figure 3. It is planned that all mill tailings will be returned to the pit for final disposition. Figure 4 is a close-up view of the mill. All components of the mill are relatively small due to the high grade of the ore.

Far East

A number of US uranium producers report receiving inquiries from sources in **Japan** concerning the availability of material for near-term purchase and delivery. However, it is most unlikely that Japanese buyers are serious about procurement of additional material in the near term. Given the extremely long position among the Japanese utilities, it seems more likely that these inquiries are designed to provide a better fix on current market conditions and price trends in a period of fairly rapid change. It is probable that such information is being sought to buttress the Japanese position as they negotiate and/or attempt to renegotiate prices with their suppliers under long term contracts. While anxious not to disturb relation-

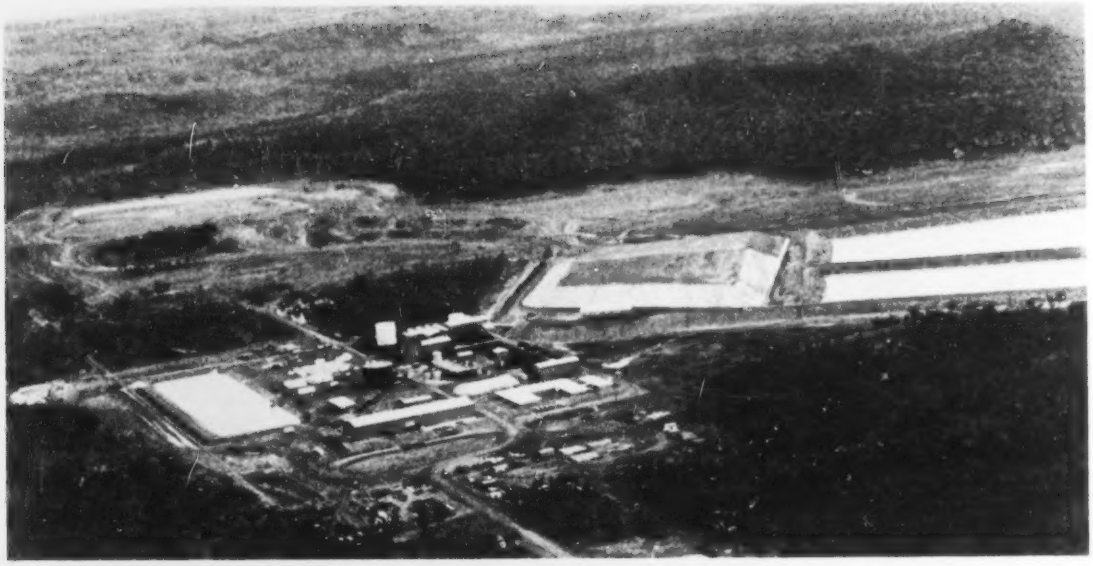

Figure 1. Aerial view of the Queensland Mines Nabarlek project. The mill is in the foreground. The ore stockpile is in the center (covered with a thin layer of concrete to protect it from the weather). The tailings evaporation pond is on the right.

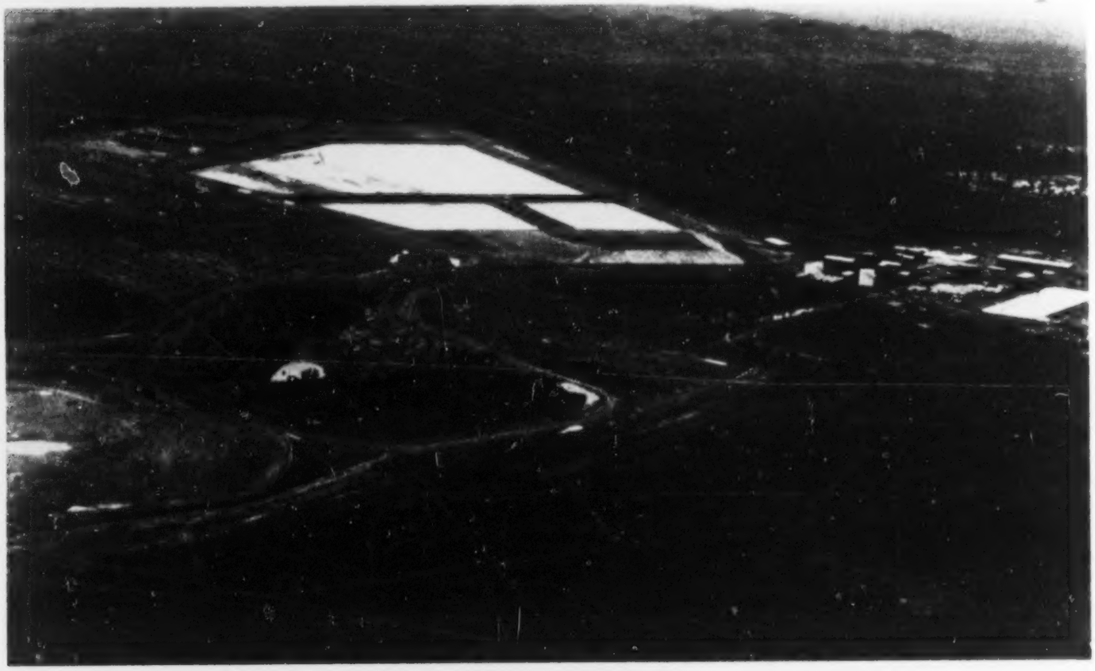

Figure 2. Another aerial view of Nabarlek, showing the mine pit in the foreground, left.

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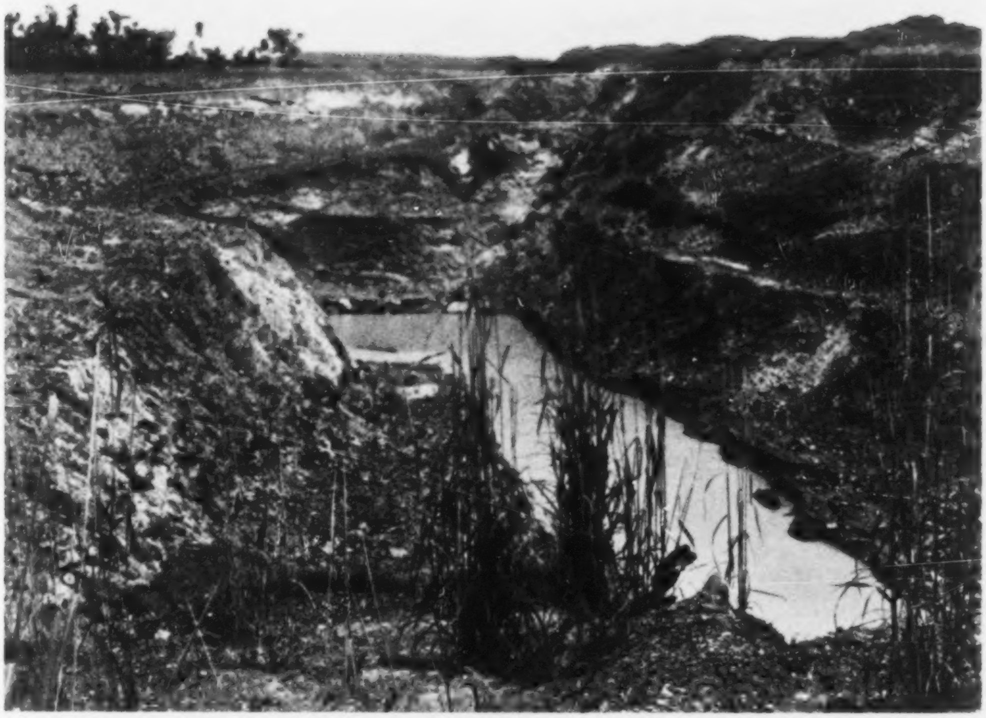

Figure 3. Close-up view of the mine pit. All mining has already been completed, and the pit will be used for final disposition of all mill tailings.

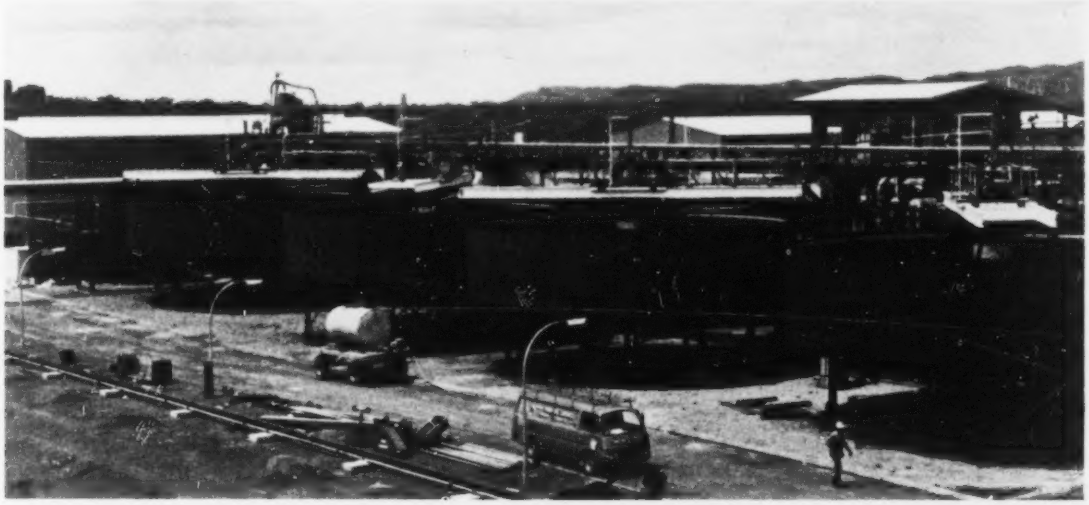

Figure 4. Close-up view of the mill site, with the thickeners in the foreground. Because of the very high grade of the Nabarlek ore (average grade is 2.35 percent U_3O_8), all mill components are relatively small.

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ships with suppliers of long standing, it can be expected that, like other buyers, the Japanese will evidence increasing sensitivity as their contract prices diverge from near-term price levels.

After negotiating with the government for some time, the Japanese private utilities were awarded rate increases effective April 1, 1980. Average nationwide residential rates in Japan will increase from 19.4 to 27.7 yen/kwhr, an increase of 43 percent. Average commercial/industrial rates will increase from 13.1 to 20.3 yen/kwhr, an increase of 54 percent. The increases are estimated to add about two percent to Japan's consumer price index, but are needed in part to offset the rising cost of fuel, and in part to finance the utilities' enormous capital investment program. For the fiscal year ending March 31, 1981, the total capital budget for the nine private utilities in Japan is about US $14,330,000,000.

United States

President Carter has apparently elected not to include the question of licensing of fuel movements in the restructuring of the US NRC which he proposed to Congress at the end of March. There had been some support for the idea of leaving nuclear export decisions solely to the US State Department. This concept was evidently too politically sensitive to include within the broader measures, and therefore, NRC's export licensing authority will remain unchanged.

Wyoming's legislature failed to pass both a 4% severance tax increase that had been proposed by the governor, and a Constitutional Amendment to raise taxes on uranium, coal, oil and natural gas. This is in contrast to New Mexico, as reported last month, where a severance tax increase was enacted.

The pattern of business in the near-term market continued as it has been since the first of the year. Volume of business transacted declined from last month, but the market is still made up of many sellers competing for a limited number of buyers. In the Market Opportunities Section of this Report (page 5.0) fourteen active inquiries are listed, involving more than 4,000,000 pounds U_3O_8 available for 1980 delivery. Only three inquiries to purchase are listed, involving a total of 1,000,000 lbs U_3O_8. There is virtually a total absence of US utility buyers for the 1980 delivery period. Further, there appears to be almost no interest among US utilities in buying for inventory. It is evident that the abnormally high interest rates in the US are contributing to the current price decline, as it becomes more and more expensive to hold inventory.

Several near-term transactions were completed in March. Price cutting by sellers was widespread, especially by those attempting to dispose of material already produced.

Pricing

The **Exchange Value** decreased again this month to $35.00 per pound U_3O_8, a drop of eight percent from last month. The reasons for the market weakness which resulted in this dramatic decline in price are summarized as follows:

—In 1979, US uranium production was about 37,000,000 pounds U_3O_8, while consumption (i.e. introduction of U_3O_8 into the enrichment-fabrication pipeline—see General Section of this Report for discussion) was approximately 25,000,000 pounds U_3O_8.

—In 1980, Nuexco expects that US production will be somewhat less than 37,000,000 pounds U_3O_8. US consumption for 1980 is expected to be about 28,500,000 pounds U_3O_8.

—Worldwide, the current situation is very similar to the US. Worldwide (outside Communist areas) production in 1979 is estimated at 98,500,000 pounds U_3O_8 compared with consumption of 68,700,000 pounds. The situation in 1980 is expected to be very similar to 1979.

—Thus in the US and the rest of the non-Communist world, uranium continues to be added to commercial inventories (i.e. the excess of production over consumption). US and total world inventory levels are already equal to about two and one-half to three years of forward consumption.

—Interest rates in the US are at record high levels. Prime lending rates of US banks are approaching 20 percent per annum, thus making the carrying of uranium inventory extremely expensive. The momentum in many US utilities is turning away from inventory buildup and toward inventory liquidation.

Inventories are playing a most important role in today's uranium market. The role is greater than expected and the market reaction is more severe than expected. The outlook is for substantial correction of inventory imbalances before the market restabilizes.

Most new inventory buildup is involuntary, as long-term contracts require buyers to continue accepting material not immediately needed. Delays in actual need have occurred for a variety of reasons including schedule deferrals, licensing delays and, in some cases, outright cancellations. There has also been a simultaneous decrease in motivations which had earlier led users to policies encouraging voluntary buildup of inventory. High cost of money, need for cash, declining uranium prices, perceptions of ample supplies, and lowered projections of installed nuclear capacity have in the minds of most utilities helped create a more relaxed inventory policy.

In the view of a number of inventory holders, now is the time to begin to make adjustments. In some cases this entails the avoidance of any further inventory buildup. In other cases, it involves reducing inventories below current levels. In either case, the end result might be the forcing of previously purchased uranium into the current market.

Since most US utilities see the inventory problem in much the same way, none are now known to be intentionally adding to inventories. None, in fact, are known to be buying even for current needs. Uranium which comes back into the market, therefore, is of marginal interest to users. Any interest in purchasing on the near-term market is mainly on the part of producers. With utilities selling and producers buying, different market forces are in operation.

With the producer as buyer, the primary market consideration is a make-or-buy decision. The near-term market price level is thus determined by a new set of conditions. In order to make a sale to a producer, the seller must be willing to price its material at a level where it will be advantageous to the producer to purchase the material, cut back on its own production, and deliver the purchased material under an existing contract. Thus the market is faced with a situation in which the only available buyers have a very practical limit on the price they are able to pay. The limit is not related to supply and demand, competitive fuels, or other normal market factors. The decision is related more to the producer's cost of production. Since the only buyers in the market are faced with an economic limit on what they are able to pay, and since there is so much material for sale relative to current demand, it is not surprising that prices are rapidly decreasing.

The longer-term effect of the current price situation may be a weakening of the US producers' position in the world market. Low prices discourage expansion. Cutbacks in production will occur as a result of decisions to buy rather than make. Overseas producers which have cost leadership positions—as nearly all do in comparison to the US—will have their positions strengthened as a result of their improved ability to compete in the lower price market.

TOPICAL ESSAY

MARKETING AND PROCUREMENT: DELIVERY AND PAYMENT

Introduction

In the negotiation of the terms and conditions of a uranium contract, delivery and payment arrangements are probably second in importance only to price provisions. This essay will review these contract terms. At the outset, it must be recognized that there is no standard industry practice in this area. Practices within the US vary widely and tend to shift with changes in market dominance. Practices in South Africa, Australia, Canada and other export sellers are often different from US practice.

The terms "delivery" and "payment" cover a number of legal and commercial factors, each of which must be considered individually. They include:

—Passage of title
—Transfer of risk of loss
—Transfer of possession of the material
—Physical movement of the material
—Location of the material
—Invoicing
—Method of payment
—Time of payment
—Amount of payment

It should be recognized that passage of title, transfer of risk of loss, physical delivery, and payment do not necessarily take place simultaneously. In some instances all may occur at different locations and different points in time. The following examples, based on actual transactions, serve to illustrate the extremes.

1. A utility purchased an amount of U_3O_8 which a producer had in its storage account at a UF_6 conversion plant. Since the material had been weighed, sampled, assayed and accepted for conversion, delivery was effected by having the conversion contractor book transfer the exact quantity of material sold from the producer's storage account to the utility's conversion account. Title and risk of loss passed to the utility upon receipt of notification from the conversion contractor that the transfer was made. Payment was made the same day by wire transfer of immediately available funds to the producer's bank. This is the simplest and most straightforward type of transaction. Passage of title, transfer or risk of loss, physical delivery and payment all occurred on the same day.

2. A utility purchased an amount of U_3O_8 from a US producer. The material was located at the producer's mill, and payment, based on the producer's preliminary determination of weight and assay, was to be made thirty days after title transfer. The contract provided that title would transfer to the utility on the first day of the month. On the seventh of the month, the material was shipped from the producer's mill to Canada for conversion. The producer retained possession (through its transportation agent) and risk of loss while the material was in the US. The utility took possession (through its transportation agent) when the material crossed the US-Canadian border on the twentieth of the month. At that time, physical delivery by the producer was completed, but the producer retained risk of loss until the material was off-loaded at the conversion plant on the twenty-third of the month. The utility made payment to the producer on the thirtieth of the month (i.e. thirty days after title transfer). In this case, the principal events, passage of title, transfer of risk of loss, physical delivery and payment each occurred at a different time and in a different location.

Title

The method of transfer of title is usually explicitly agreed on by the buyer and seller in the sales contract. Title usually passes upon the occurrence of some specific event. Some events which have been used to trigger the transfer of title in uranium sales contracts are:

—Shipment from a producer's mill.
—Arrival or off-loading at a weighing and sampling facility, adjacent to a UF_6 conversion plant.
—Acceptance by a UF_6 conversion contractor for conversion.
—In a sale of UF_6, arrival or off-loading at an enrichment facility, or acceptance of the material for enrichment.
—In an export sale, arrival at the dock or airport, loading or off-loading of the ship or airplane, or border crossing.
—In a sale not involving movement, a book transfer by the party in possession of the material, such as a conversion contractor, US DOE or other enrichment contractor, or a storage facility.
—Receipt by buyer of notification that any of the

above events have occurred.

- —Receipt by buyer of seller's invoice.
- —Receipt by buyer of a document of title, such as a bill of lading, or a warehouse receipt.

The parties may also agree that title will pass on a specific date, or on a specific number of days after one of the above events, or some combination of an event and a date. Some sales contracts are silent on the passage of title. Under the US Uniform Commercial Code (which is law in every state in the US except Louisiana), title passes in any manner agreed on by the parties, but if there is no explicit agreement, Section 2-401 of the Code contains rules which govern the passage of title. Section 2-401 is reproduced for reference in the Appendix to this essay.

Risk of Loss

As the name implies, the party with risk of loss is the one which must suffer the financial burden of destruction of the material, such as in a shipwreck, or other loss of the material, such as by impoundment. Most sales contracts contain explicit provisions for the transfer of risk of loss in the material; such provisions usually apply only *as between the buyer and seller*. The party with physical possession of the material (e.g. a shipper, conversion contractor or storage facility), normally accepts the risk of loss under contract to the buyer or seller or both, and the party in possession usually covers risk of loss by an insurance policy.

Passage of risk of loss from seller to buyer is usually triggered by a specific event. Any of the events listed above which can trigger passage of title can also transfer risk of loss. It is important to recognize, however, that title and risk of loss do not have to pass at the same time. The contract may be arranged such that title will pass on the occurrence of one event, and risk of loss will pass on the occurrence of a later event. Or risk of loss may pass first, and title later. The Uniform Commercial Code has settled the issue in the US that a party does not have to have title to goods to bear the risk of loss in them.

Normally the buyer and seller will explicitly agree in the sales contract as to when risk of loss passes. In the absence of such an explicit agreement, the Uniform Commercial Code, Section 2-509, contains rules which govern passage of risk of loss. Section 2-509 is reproduced for reference in the Appendix to this essay.

Physical Delivery

Delivery, apart from passage of title and risk of loss, might involve both physical movement and change of possession of the material, or delivery may take place without moving the material. In the uranium industry, delivery is normally accomplished by one of the following methods:

Shipment to destination. The seller puts the material in possession of carrier (truck, rail, ship, or air) under a contract to ship the material to a specific destination. For example, a seller may complete physical delivery by loading the material aboard a truck at the millsite under a contract with the carrier to ship the material to a UF_6 conversion plant. Or in an export sale, the seller may complete physical delivery by loading the material aboard a ship under a contract with the carrier to ship the material to a specific port. Shipping cost may or may not be prepaid by the seller, depending on the agreement of the parties.

Delivery at destination. The seller completes delivery upon the arrival of the material at a specific destination. That destination is often a UF_6 conversion plant, or a storage facility, and delivery can be completed either by arrival of the carrier at the plant, or off-loading of the material from the carrier. In an export sale, delivery is often completed by the arrival or off-loading of the truck or rail carrier at the port of exit, or the arrival or off-loading of the ship or air carrier at the port of entry. Some export sales also involve physical delivery to a conversion plant or storage facility.

Delivery without movement. Some uranium sales involve delivery of the material without moving it. If the material is in the hands of a third party (e.g. a conversion contractor, storage facility, enrichment contractor, or other bailee), delivery without movement would normally require some form of acknowledgment by the third party of the buyer's rights in the material. For example, if delivery is to be made by book transfer at a conversion plant, it would usually be necessary for the conversion contractor to provide notification to the buyer that the transfer has been made to the buyer's account.

If delivery is to be made at the seller's mill, without moving the material, it would usually be necessary that the material be identified by the seller, and that the seller provide a document of title to the buyer.

Sections 2-503 and 2-504 of the Uniform Commercial Code cover delivery by the seller. These sections are reproduced for reference in the Appendix to this essay.

F.O.B. and C.I.F. Terms

The terms *F.O.B.* (free on board) and *C.I.F.* (cost, insurance and freight) are often used in uranium sales contracts. The term *F.O.B. place of shipment* normally means that the seller must place the material in the possession of the shipper, and bear the risk and expense of doing so. Thus a delivery F.O.B. place of shipment usually means that both physical delivery and passage of risk of loss occur at the time when the seller puts the material in the possession of the shipper.

The term *F.O.B. place of destination* normally means that the seller must transport the goods to the place of destination and bear the risk and expense of doing so. Thus a delivery F.O.B. place of destination usually means that both physical delivery and passage of risk of loss take place when the material arrives at the named destination.

The terim *C.I.F. destination* means that the price of the material includes the cost of freight and insurance to a named destination. Under a C.I.F. contract, the seller would put the material in the possession of the shipper under a contract to ship the material to the named destination. Normally, the seller would then send its invoice for the material to the buyer, accompanied by the bills of lading issued by the shipper, and the appropriate certificates of insurance.

Payment

Payment under a uranium sales contract is often triggered by the same event which causes the transfer of title to the buyer. It can also be triggered by delivery, by a combination of title transfer and delivery, or by the passage of a certain date. Normally, payment is effected by wire transfer of funds to the seller's bank on the specified payment date.

Except in very simple contracts, the Seller will usually be required to submit an invoice prior to payment. If payment is to be made on the basis of the seller's preliminary determination of weights and assays, there will be a provision in the contract for the buyer and seller to settle any differences after final weights and assays become available. Where provisional payments are made, sometimes only a portion of the seller's estimated invoice, usually 95 percent, is paid initially, with the balance due after final determination of uranium content. In some contracts, 100 percent of the seller's preliminary invoice is paid initially, with the seller or buyer making a final payment for any overage or shortfall, based on final weights and assays.

In export sales, payment is often made by letter of credit. The bank on which the letter of credit is drawn would be invoiced by the seller, and any documents evidencing delivery and/or title transfer would also be presented directly to the bank.

Some typical examples of payment provisions are:

—Payment due by wire transfer to seller's account within X days (e.g. 15 days, 30 days) after shipment of concentrates from the seller's mill, provided that buyer will have received notification that the material has arrived at the delivery location.

—Payment due by wire transfer within X days after receipt by buyer of both seller's invoice and notification from a conversion contractor that the material has been off-loaded at the weighing and sampling facility.

—Payment due by wire transfer within X days after receipt by buyer of Seller's invoice accompanied by bills of lading evidencing that the material has been loaded aboard a carrier (e.g. air, ship) under contract to ship the material to the agreed on destination.

APPENDIX

Sections of the Uniform Commercial Code on Title, Risk of Loss, and Delivery.

Section 2-401. Passing of Title; Reservation for Security; Limited Application of this Section.

Each provision of this Article with regard to the rights, obligations and remedies of the seller, the buyer, purchasers or other third parties applies irrespective of title to the goods except where the provision refers to such title. Insofar as situations are not covered by the other provisions of this

Article and matters concerning title become material, the following rules apply:

1. Title to goods cannot pass under a contract for sale prior to their identification to the contract (section 2-501), and unless otherwise explicitly agreed the buyer acquires by their identification a special property as limited by this chapter. Any retention or reservation by the seller of the title (property) in goods shipped or delivered to the buyer is limited in effect to a reservation of a security interest. Subject to these provisions and to the provisions of the Article on Secured Transactions (Article 9), title to goods passes from the seller to the buyer in any manner and on any conditions explicitly agreed on by the parties.

2. Unless otherwise explicitly agreed, title passes to the buyer at the time and place at which the seller completes his performance with reference to the physical delivery of the goods, despite any reservation of a security interest and even though a document of title is to be delivered at a different time or place; and in particular despite any reservation of a security interest by the bill of lading

a. if the contract requires or authorizes the seller to send the goods to the buyer but does not require him to deliver them at destination, title passes to the buyer at the time and place of shipment; but

b. if the contract requires delivery at destination, title passes on tender there.

3. Unless otherwise explicitly agreed where delivery is to be made without moving the goods

a. if the seller is to deliver a document of title, title passes at the time when and the place where he delivers such documents; or

b. if the goods are at the time of contracting already identified and no documents are to be delivered, title passes at the time and place of contracting.

4. A rejection or other refusal by the buyer to receive or retain the goods, whether or not justified, or a justified revocation of acceptance revests title to the goods in the seller. Such revesting occurs by operation of law and is not a "sale."

Section 2-503. Manner of Seller's Tender of Delivery

1. Tender of delivery requires that the seller put and hold conforming goods at the buyer's disposition and give the buyer any notification reasonably necessary to enable him to take delivery. The manner, time and place for tender are determined by the agreement and this Article, and in particular

a. tender must be at a reasonable hour, and if it is of goods, they must be kept available for the period reasonably necessary to enable the buyer to take possession; but

b. unless otherwise agreed, the buyer must furnish facilities reasonably suited to the receipt of the goods.

2. Where the case is within the next section respecting shipment tender requirements that the seller comply with its provisions.

3. Where the seller is required to deliver at a particular destination tender requires that he comply with subsection 1 and also in any appropriate case tender documents as described in subsections 4 and 5 of this section.

4. Where goods are in the possession of a bailee and are to be delivered without being moved

a. tender requires that the seller either tender a negotiable document of title covering such goods or procure acknowledgment by the bailee of the buyer's rights to possession of the goods; but

b. tender to the buyer of a non-negotiable document of title or of written direction to the bailee to deliver is sufficient tender unless the buyer seasonably objects, and receipt by the bailee of notification of the buyer's rights fixes those rights as against the bailee and all third persons; but risk of loss of the goods and of any failure by the bailee to honor the non-negotiable document of title or to obey the direction remains on the seller until the buyer has had a reasonable time to present the document or direction, and a refusal by the bailee to honor the document or to obey the direction defeats the tender.

5. Where the contract requires the seller to deliver documents

a. he must tender all such documents in correct form, except as provided in this Article with respect to bills of lading in a set (subsection 2 of section 2-323); and

b. tender through customary banking channels is sufficient and dishonor of a draft accompanying the documents constitutes non-acceptance or rejection.

TOPICAL ESSAY

Section 2-504. Shipment by Seller.

Where the seller is required or authorized to send the goods to the buyer and the contract does not require him to deliver them at a particular destination, then unless otherwise agreed he must

1. Put the goods in the possession of such a carrier and make such a contract for their transportation as may be reasonable having regard to the nature of the goods and other circumstances of the case; and
2. Obtain and promptly deliver or tender in due form any document necessary to enable the buyer to obtain possession of the goods or otherwise required by the agreement or by usage of trade; and
3. Promptly notify the buyer of the shipment.

Failure to notify the buyer under paragraph 3 or to make a proper contract under paragraph 1 is a ground for rejection only if material delay or loss ensues.

Section 2-509. Risk of Loss in the Absence of Breach

1. Where the contract requires or authorizes the seller to ship the goods by carrier

    a. if it does not require him to deliver them at a particular destination, the risk of loss passes to the buyer when the goods are duly delivered to the carrier even though the shipment is under reservation (section 2-505); but

    b. if it does not requirc him to deliver them at a particular destination and the goods are there duly tendered while in the possession of the carrier, the risk of loss passes to the buyer when the goods are there duly so tendered as to enable the buyer to take delivery.

2. Where the goods are held by a bailee to be delivered without being moved, the risk of loss passes to the buyer

    a. on his receipt of a negotiable document of title covering the goods; or

    b. on acknowledgment by the bailee of the buyer's right to possession of the goods; or

    c. after his receipt of a non-negotiable document of title or other written direction to deliver, as provided in subsection 4(b) of Section 2-503.

3. In any case not within subsection 1 or 2, the risk of loss passes to the buyer on his receipt of the goods if the seller is a merchant; otherwise the risk passes to the buyer on tender of delivery.
4. The provisions of this section are subject to contrary agreement of the parties and to the provisions of this Article on sale on approval (section 2-327) and on effect of breach on risk of loss (section 2-510).

Quartz-pebble Conglomerates—Part I

Introduction

Uranium mineralization is present in almost every occurrence of quartz-pebble conglomerate throughout the world.

The conglomerates in the Elliot Lake district of Ontario, Canada, and the Witwatersrand district of the Republic of South Africa contain uranium in economically recoverable amounts. The uranium contained in the conglomerates of these two districts represents about 25 percent of the world's known reserves. The recoverable uranium reserves of the presently defined Elliot Lake district are roughly estimated at nearly 1,000,000,000 pounds U_3O_8. Perhaps even more impressive is the fact that the largest single ore deposit identified to date at Elliot Lake (the Quirke zone) contains over 600,000,000 pounds U_3O_8, making it one of the largest uranium deposits ever discovered.

Uranium was first recovered as a by-product of gold production from the Witwatersrand conglomeritic reefs (mineralized beds) in 1952, and as the primary mineral in the Elliot Lake reefs in 1954. Production from both districts has continued since then. Total uranium production to date from quartz-pebble conglomerates is 225,000,000 pounds U_3O_8 in South Africa and 210,000,000 pounds U_3O_8 in Canada. Over 99 percent of all uranium currently being produced in South Africa, and about 60 percent of that currently being produced in Canada, is from quartz-pebble conglomerates.

The uranium potential of conglomerates in other countries is being evaluated at this time, including Jacobina (Brazil), Rum Jungle (Australia), Karnataka (India) and Tarkwa (Ghana). Other areas of interest are southwestern Russia, northern Finland and the western US. Figure 5 is a world map showing the location of Early Proterozoic uraniferous quartz-pebble conglomerates and related sediments.

Genesis of Quartz-Pebble Conglomerates

Most uranium-bearing quartz-pebble conglomerates are restricted to rocks of Early Proterozoic age, about the middle of the Precambrian Era. Quartz-pebble conglomerates are time-bound between older Archean rocks, which are not known to contain economically recoverable uranium deposits, and Middle Proterozoic rocks which contain both unconformity-related and vein deposits. (e.g. Saskatchewan and the Northern Territory of Australia). Table 4 has been prepared to illustrate this geologic relationship.

Table 4
URANIUM OCCURRENCES IN PRECAMBRIAN SUBDIVISIONS

Subdivision	Age (millions of years)	Uranium Occurrences
Late Proterozoic	900-570	
Middle Proterozoic	1600-900	Unconformity, vein
Early Proterozoic	2500-1600	Quartz-pebble conglomerates
Late Archean	2900-2500	
Middle Archean	3300-2900	
Early Archean	more than 3300	

The majority of uranium-bearing conglomerates, especially those in South Africa and Canada, are restricted to the depositional period of the first half of the Early Proterozoic age. The geologic changes which took place during the extremely long transition from Archean through Early Proterozoic were dramatic. During this time, there was a marked increase in global tectonic activity resulting in an obvious change in the depositional sequence of different types of clastic sediments in structural basins. The quartz-pebble conglomerates were among the first clastics to be deposited—in some instances, directly upon Archean metamorphic and granitic rocks. The coarse fraction was rapidly deposited along the edges of catchment basins. The finer fraction was transported basinward by coalescing stream action to accumulate in blanket deposits many meters thick. Such depositional patterns resulted in characteristic placer deposits with the largest rock and heavy mineral constituents deposited closer to the source areas. The greatest accumulation of minerals was along the basin-fringe area, as in the Witwatersrand district, which contains gold and uranium, and the Elliot Lake district, which contains uranium.

The physical characteristics of both districts are similar, as are their ages. The conglomerates are generally composed of 70 to 85 percent quartz-pebbles and 15 to 25 percent vein quartz, chert and quartz porphyry pebbles. Uranium mineralogy is primarily uraninite at Witwatersrand and brannerite

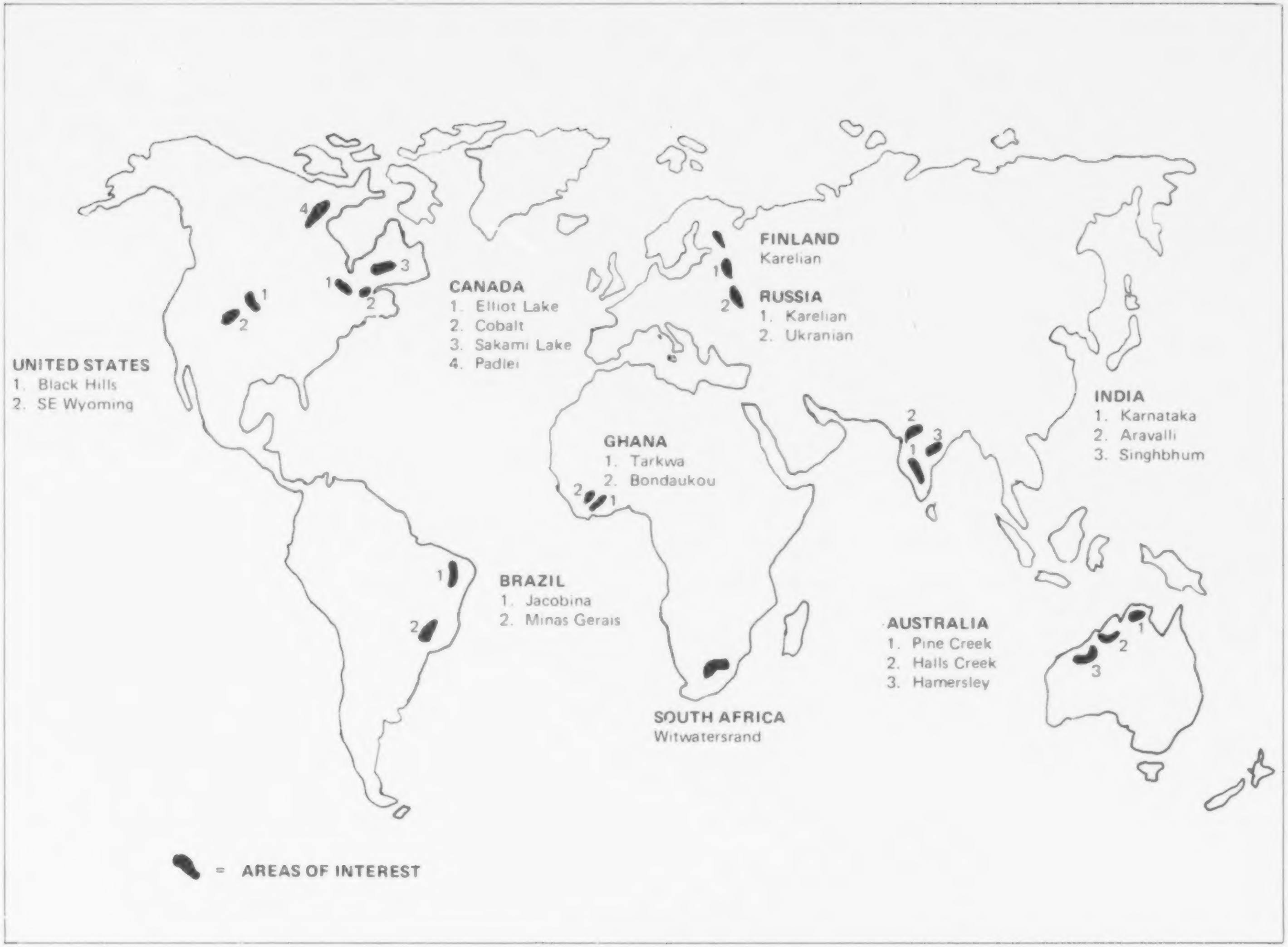
UNITED STATES
1. Black Hills
2. SE Wyoming
CANADA
1. Elliot Lake
2. Cobalt
3. Sakami Lake
4. Padlei
FINLAND
Karelian
RUSSIA
1. Karelian
2. Ukranian
INDIA
1. Karnataka
2. Aravalli
3. Singhbhum
GHANA
1. Tarkwa
2. Bondaukou
BRAZIL
1. Jacobina
2. Minas Gerais
AUSTRALIA
1. Pine Creek
2. Halls Creek
3. Hamersley
SOUTH AFRICA
Witwatersrand
1
2
3
4
= AREAS OF INTEREST

Figure 5.

LOCATION MAP OF WORLD-WIDE OCCURRENCES OF EARLY PROTEROZOIC QUARTZ-PEBBLE CONGLOMERATES AND RELATED SEDIMENTS.

at Elliot Lake, although both minerals are known to occur in each district. The uranium occurs as a small portion of the conglomerate matrix, which may contain 15 to 20 percent pyrite and an assortment of other minerals, most of which are not economically recoverable.* All rock and mineral products making up the conglomerate originated from Archean basement rocks. The contained minerals are considered to be detrial, or placer, in origin.

Genesis of Ore Minerals

Not all conglomeritic units are mineralized. Mineral-bearing units often occur in multiple or stacked zones. They may be separated by barren conglomerate, quartzite or sandstone units which vary in thickness from a few centimeters to many meters. The minerals are generally localized along unconformable contacts with lower barren units; otherwise, all conglomeritic units have similar depositional characteristics. This supports the theory that significant geologic changes occurred during Late Archean/Early Proterozoic time.

The origin of the conglomerates and associated mineralization has been controversial. There are two principal theories—the minerals are either syngenetic or epigenetic. The favored theory of ore genesis is syngenetic, whereby the ore minerals are derived from Archean rocks, transported and deposited with the quartz-pebble conglomerates, forming what is known as a placer deposit. The ore minerals and the quartz-pebbles are well-rounded and well-sorted, indicating movement basinward from adjacent highlands into stream channels, with coalescing depositional patterns. There is also evidence of redistribution by wave action prior to burial and compaction. All constituents within the conglomeritic units are considered to be syngenetic—the ore minerals and the quartz-pebbles were deposited contemporaneously and probably from the same source area. Uranium, gold and pyrite are part of the heavy mineral fraction concentrated near the base of mineralized conglomerate and/or within topographic depressions formed on the Archean erosion surface.

The relationship between the specific gravity of the heavy minerals and the size of the particles (2.0 mm down to 0.01 mm) also supports the placer theory. Gold is the heaviest mineral and, at the Witwatersrand, it shows greater concentration near the source area than either uranium or sulfide minerals. The mineral mix is moderate to fine gold with coarse uranium and pyrite, moderate to fine uranium with coarse pyrite. Further basinward, the mix is mainly fine pyrite with only a trace of uranium and perhaps no gold at all. The depositional pattern is similar at Elliot Lake, but without the gold.

The age of the ore minerals at the Witwatersrand further supports the placer theory. The Witwatersrand sequence rests unconformably upon Archean granites, restimated to be Middle to Late Archean. the ore minerals in the lower conglomerates have been dated to 3100 to 3000 million years, while the Witwatersrand sequence has been dated to about 2800 to 2300 million years.

The epigenetic origin of the ore minerals relates to the theory that the minerals precipitated from mineral-bearing hydrothermal solutions emanating from Archean rocks, and were introduced into the conglomerates. Supporting evidence of hydrothermal origin are the following: the occasional occurrence of irregularly shaped gold nuggets; the partial replacement of quartz-pebbles by pyrite; and veinlets of gold-cutting quartz-pebbles and pyrite grains—common hydrothermal characteristics. This suggests that the deposits are at least modified placers and the minerals may be epigenetic.

Geologic evidence definitely favors the syngenetic theory of ore genesis. However, consideration should be given to geologic change and the effect it has had on ore minerals—a local situation. There is evidence in the Witwatersrand reefs showing that a small amount of uranium has been redistributed and recrystalized due to continued structural movement and metamorphism. The uranium minerals at both Elliot Lake and Jacobina, Brazil show evidence of alteration and mobilization. It is likely that the changes took place during a long period of metamorphosis. In fact, brannerite, the primary uranium mineral at Elliot Lake, shows alteration characteristics which indicate the mineral may be of epigenetic origin—at least locally. Overall, the genesis of the uranium minerals in the quartz-pebble reefs is considered to be syngenetic.

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*Rare earths are recovered as a by-product to uranium in the Elliot Lake district.

Epigenetic minerals have formed locally due to geologic changes.

Ore Values

The uranium content in the quartz-pebble reefs is relatively low compared to the unconformity and vein deposits of Middle Proterozoic age, and the sandstone deposits of Mesozoic age. The average grade of uranium recovered along with gold at the Witwatersrand is in the range of 0.01 percent to 0.03 percent U_3O_8. The average grade of ore at Elliot Lake varies from about 0.07 percent to 0.15 percent U_3O_8. Occasionally, higher grade zones are encountered during mining, especially at Elliot Lake.

STATISTICAL DATA

EXCHANGE VALUE—$35.00/lb U_3O_8
Determined as of March 31, 1980

DEFINITION

The Exchange Value is Nuexco's judgment of the price at which transactions for significant quantities of natural uranium concentrates could be concluded as of the last day of the month.

DERIVATION

Nuexco bases the Exchange Value upon:

A. Data from recently completed transactions.
B. Data from pending transactions.
C. Firm bids to buy and firm offers to sell.
D. Prices purchasers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy, and prices sellers have expressed a willingness to accept, but for which Nuexco is not aware of firm offers to sell.

COMMENTS

Nuexco does not consider the following in determining the Exchange Value:

A. The price of uranium delivered or to be delivered under old contracts.
B. The price of uranium delivered in connection with contract renegotiations or other than arm's length transactions.

TRANSACTION VALUE
Determined as of March 31, 1980

$/lb U_3O_8	Millions of Pounds	Number of Transactions	Number of Months
38.60	3.6	11	3

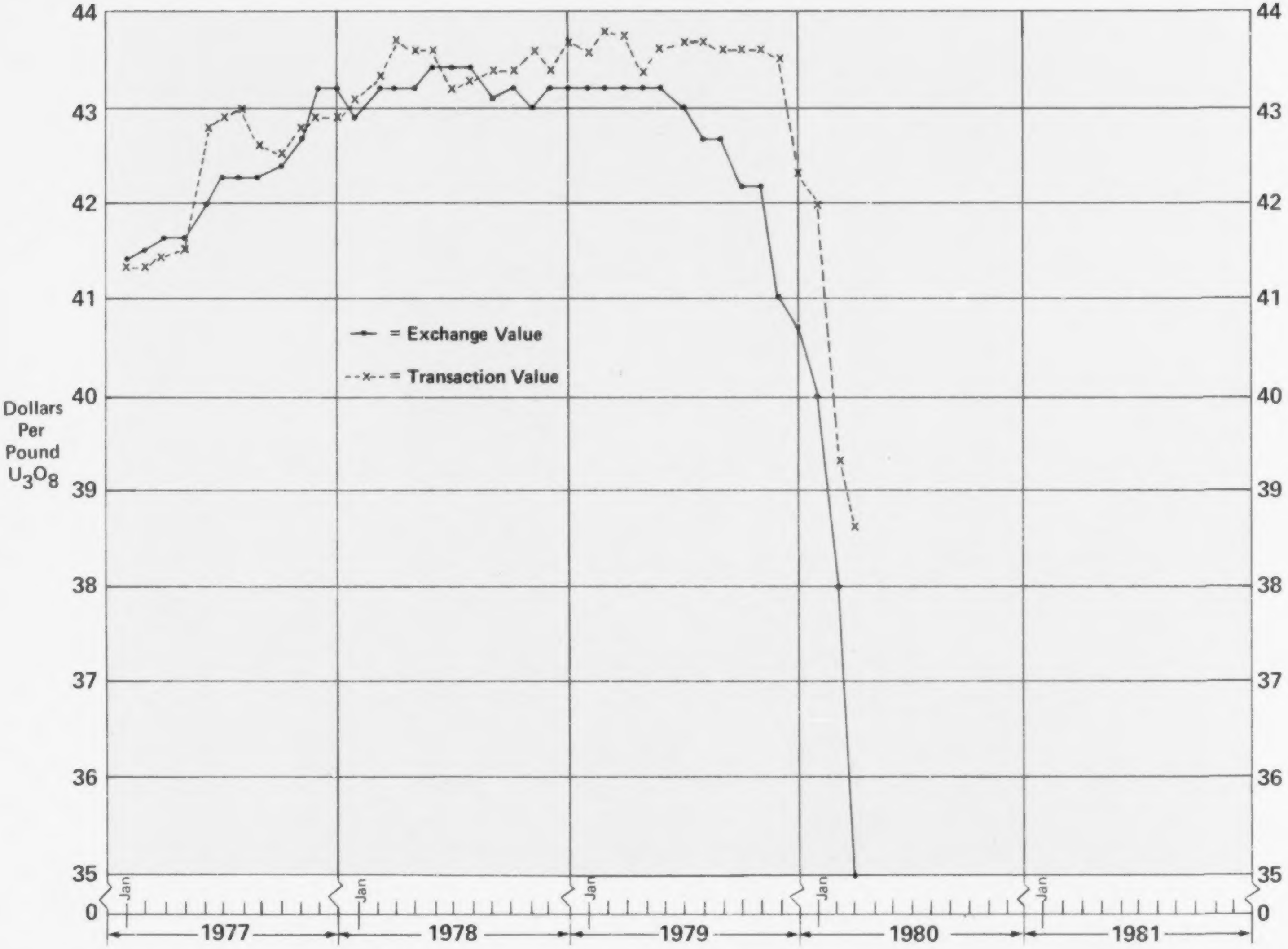
DEFINITION

The Transaction Value is a weighted average price of recent transactions, and is based on prices paid for U_3O_8 in transactions closed within the previous three-month period and for which delivery was scheduled within one year of the transaction date. At least ten transactions totaling at least two million pounds U_3O_8 are included in each calculation, or the sample time is extended as necessary to include these minima. Foreign currencies are converted to US dollars as of the transaction date.

EXCHANGE AND TRANSACTION VALUES SINCE JANUARY 1977

Determined as of the last day of the month indicated

US Dollars/lb. U_3O_8

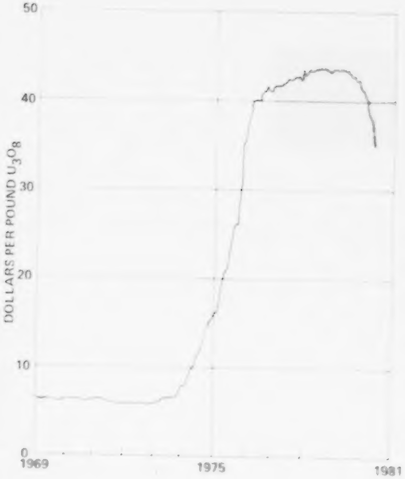


NUEXCO

HISTORICAL EXCHANGE VALUES

Determined as of the last day of the month indicated

US Dollars/lb. U_3O_8



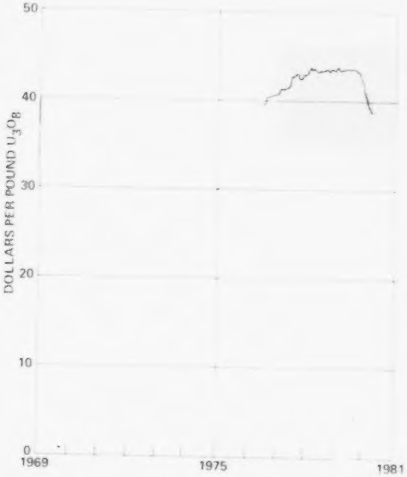
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1968	–	–	–	–	–	–	–	6.35	6.35	6.40	6.45	6.50
1969	–	6.35	6.10	6.10	6.25	6.25	6.20	6.20	6.15	6.15	6.15	6.20
1970	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.20	6.15	6.15	6.15	6.15
1971	6.20	6.20	6.20	6.20	6.15	6.05	6.00	5.95	5.95	5.95	5.95	5.95
1972	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95
1973	5.95	6.00	6.10	6.20	6.45	6.50	6.50	6.50	6.50	6.50	6.75	7.00
1974	7.70	7.90	8.00	9.00	9.50	10.50	11.50	12.00	12.50	14.00	14.75	15.00
1975	16.00	16.00	18.00	20.00	21.00	23.00	24.70	26.00	26.00	28.50	30.00	35.00
1976	35.20	37.00	39.25	40.00	40.00	40.00	40.00	40.40	41.00	41.00	41.50	41.00
1977	41.35	41.50	41.60	41.60	42.00	42.25	42.25	42.25	42.40	42.75	43.20	43.20
1978	42.90	43.25	43.25	43.25	43.40	43.40	43.40	43.10	43.25	43.00	43.25	43.25
1979	43.25	43.25	43.25	43.25	43.25	43.00	42.70	42.70	42.20	42.20	41.00	40.75
1980	40.00	38.00	35.00									

Note: See earlier Nuexco Reports for evolution of the definition of Exchange Value.

HISTORICAL TRANSACTION VALUES

Determined as of the last day of the month indicated

US Dollars/lb. U_3O_8



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1976	–	–	–	–	39.60	39.70	39.70	40.40	40.30	40.60	40.70	40.70
1977	41.30	41.30	41.40	41.50	42.80	42.90	43.00	42.60	42.50	42.80	42.90	42.90
1978	43.10	43.30	43.70	43.60	43.60	43.20	43.30	43.40	43.40	43.60	43.40	43.70
1979	43.60	43.80	43.70	43.40	43.60	43.70	43.70	43.60	43.60	43.60	43.50	42.30
1980	42.00	39.30	38.60									

Note: See Nuexco Report No. 135, dated October 31, 1979, for a discussion of the definition of Transaction Value.

STATISTICAL DATA

EXCHANGE VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES*

Country	per lb U_3O_8 in Concentrates	per kg U_3O_8 in Concentrates	per kg U in Concentrates
US (dollar)	35.00	77.16	90.99
France (franc)	155.76	343.40	404.95
FRG (mark)	67.55	148.93	175.63
Japan (yen)	8,726	19,238	22,686
Switzerland (franc)	64.09	141.30	166.62
UK (pound)	16.06	35.41	41.76
Australia (dollar)	32.26	71.12	83.86
Canada (dollar)	41.55	91.61	108.03
Niger, Gabon (CFA)	7,788	17,170	20,247
South Africa (rand)	28.34	62.48	73.68

* Calculated using currency exchange rates published in the Wall Street Journal on the last business day of the month.

LOAN USE CHARGE RATE — 7.0%/year

DEFINITION

The Loan Use Charge Rate is Nuexco's judgment of the annual interest rate at which uranium loans could be concluded as of the last day of the month.

DERIVATION

Nuexco bases the Loan Use Charge Rate upon:

A. Data from recently completed or pending loan transactions.
B. Rates included in firm proposals to borrow or lend.
C. Rates that potential borrowers and lenders have expressed a willingness to pay or accept, but for which Nuexco is not aware of firm proposals.

STATISTICAL DATA

CURRENT TRANSACTIONS*

Nuexco Ref Number	Delivery Period	Approximate Quantity (thousands of pounds, U_3O_8 equivalent)	Approximate Price as percent of Current E.V.	Seller Group	Buyer Group	Remarks
1070	80	100 to 300	–	US	US	Loan – Repayment in 1981
1071	80	100 to 300	101	US	US	
1081	thru 91	7,000 to 10,000	–	Africa	Far East	Price related to market at time of delivery
1090	80	Less than 50	102	US	US	
1093	80	300 to 600	92	Europe	US	Enriched UF_6

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* Transactions listed include not only those in which Nuexco was involved, but also all others of which Nuexco is aware.

US GOVERNMENT STATISTICS

	Producer Price Index–Industrial Commodities (1967 = 100)(1)	Consumer Price Index (1967 = 100)(2)	GNP Implicit Price Deflator (1972 = 100)(3)	Gross Average Hourly Earnings of Production or Non-supervisory Workers (US$)(4)		
				Metal Mining (SIC 10)	**Primary Non-ferrous Metals (SIC 333)**	**Chemicals and Allied Products (SIC 28)**
Annual Avg. 1970(5)	110.0	116.3	91.36	3.88	3.87	3.69
Annual Avg. 1971(5)	114.0	121.3	96.02	4.12	4.15	3.94
Annual Avg. 1972(5)	117.9	125.3	100.00	4.49	4.59	4.21
Annual Avg. 1973(5)	125.9	133.1	105.80	4.82	4.98	4.48
Annual Avg. 1974(5)	153.8	147.7	116.02	5.43	5.63	4.85
Annual Avg. 1975(5)	171.5	161.2	127.15	6.13	6.24	5.37
Annual Avg. 1976(5)	182.3	170.5	133.71	6.75	6.87	5.89
Annual Avg. 1977(5)	195.1(4)	181.5	141.70	7.28	7.67	6.43
Annual Avg. 1978(5)	209.4	195.4	152.05	8.23	8.56	7.01
Dec 1978	217.2	202.9	156.68	8.72	8.97	7.28
Jan 1979	220.0	204.7	–	8.71	9.01	7.32
Feb 1979	222.5	207.1	–	8.81	9.02	7.32
Mar 1979	225.4	209.1	160.22	8.84	9.11	7.36
Apr 1979	229.0	211.5	–	9.03	9.49	7.50
May 1979	231.6	214.1	–	9.06	9.15	7.47
Jun 1979	234.0	216.6	163.81	9.09	9.44	7.53
Jul 1979	237.5	218.9	–	9.32	9.57	7.60
Aug 1979	240.6	221.1	–	9.38	9.70	7.65
Sep 1979	244.2R	223.4	167.20	9.63	9.79	7.73
Oct 1979	248.5	225.4	–	9.67	9.87	7.82
Nov 1979	250.2	227.5	–	9.79	9.86	7.87
Dec 1979	252.8	229.9	170.71P	9.81	9.92	7.91
Jan 1980	260.3	233.2	–	9.94P	10.09P	7.94P
Feb 1980	265.4	236.4	–	–	–	7.95P

P = Preliminary R = Revised since last month

(1) US Bureau of Labor Statistics, Washington, D.C.; "Producer Prices and Price Indexes," Table 6 (formerly "Wholesale Prices and Price Indexes"). Producer Price Indexes are revised four months after they are first released to reflect the availability of late reports and corrections by respondents.

(2) US Bureau of Labor Statistics, Washington, D.C.; Consumer Price Index for All Urban Consumers, US City Average, All Items.

(3) US Department of Commerce, Washington, D.C.; Bureau of Economic Analysis, National Income and Wealth Division; "Survey of Current Business," Table A. The GNP Implicit Price Deflator is published quarterly, and seasonally adjusted.

(4) US Bureau of Labor Statistics, Washington, D.C.; "Employment and Earnings," Table C-2. All data based on 1972 revision of SIC Manual. Data for 1970-1976 are adjusted to the March 1977 benchmark. All data for 1977 and beyond are adjusted to the most recent benchmark – March 1978 – and are subject to revision from that point forward with the advent of the next benchmark scheduled for publication in late 1980.

(5) Data for these years, monthly except for the GNP Implicit Price Deflator, appear on pages 4.6 through 4.8 of Report No. 139, dated March 1980.

STATISTICAL DATA

CANADIAN GOVERNMENT STATISTICS

	Industry Selling Price Index: Manufacturing (D 500000) [(1), (2)] (1971 = 100.0)	Wage-earner Data: Average Hourly Earnings ($C) [(3), (4)]		
		Metal Mining, including milling (SIC 050-059)	**Primary Metal Industries, non-ferrous (SIC 296-298)**	**Chemicals and Chemical Products (SIC 370-379)**
Annual Avg. 1977	174.3	8.18	6.50	6.51
Annual Avg. 1978	190.4	8.76	6.82	6.97
Nov 1978	198.6	9.18	7.09	7.14
Dec 1978	199.4	9.29	6.93	7.14
Jan 1979	204.8	9.19	7.14	7.29
Feb 1979	208.5	9.24	7.18	7.36
Mar 1979	210.4	9.47	7.20	7.51
Apr 1979	212.8	9.68	7.26	7.63
May 1979	214.5	9.65	7.28	7.61
Jun 1979	216.0	9.49	7.27	7.66
Jul 1979	218.3	9.37	7.34	7.73
Aug 1979	220.0	9.56	7.38	7.77
Sep 1979	223.4	9.75	7.50	7.81
Oct 1979	227.4R	10.03	7.54	7.88
Nov 1979	228.1	9.97	7.61	7.91
Dec 1979	230.3R	9.90P	7.50P	7.90P
Jan 1980	238.0P	—	—	—

P = Preliminary
R = Revised since last month

(1) Statistics Canada, Prices Division, Ottawa; "Industry Price Indexes" (Catalogue 62-011), Table 1. Indexes for the most recent six months shown are subject to revision.

(2) Monthly data for 1973 through 1978 appear on page 4.10 of Report No. 138, dated January 31, 1980.

(3) Statistics Canada, Labour Division, Employment and Payrolls Section, Ottawa; "Employment, Earnings and Hours" (Catalogue 72-002), Table 2.

(4) Monthly data for 1977 and 1978 appear on page 4.11 of Report No. 138, dated January 31, 1980.

STATISTICAL DATA

AUSTRALIAN GOVERNMENT STATISTICS

	Price Index of Materials Used in Manufacturing Industry – All Groups (Year 1968-69 = 100.0)(1)	Weighted Average Minimum Weekly Wage Rates – Adult Males Australia Mining and Quarrying (A$)(2)
Annual Avg. 1970(3)	101.4	59.88
Annual Avg. 1971(3)	101.5	65.95
Annual Avg. 1972(3)	105.6	71.26
Annual Avg. 1973(3)	124.4	78.96
Annual Avg. 1974(3)	141.9	108.07
Annual Avg. 1975(3)	150.4	132.55
Annual Avg. 1976(3)	168.4	160.93
Annual Avg. 1977(3)	192.0	179.03
Annual Avg. 1978(3)	215.4	190.04
Oct 1978	230.3	190.56
Nov 1978	232.2	190.86
Dec 1978	235.7	199.28R
Jan 1979	246.3	199.79R
Feb 1979	253.0	200.00
Mar 1979	264.0	201.45R
Apr 1979	273.0	202.27
May 1979	287.5	203.38R
Jun 1979	293.8	209.88R
Jul 1979	295.8	210.49R
Aug 1979	290.8	211.56
Sep 1979	300.0	212.34R
Oct 1979	307.0	211.80R
Nov 1979	308.0P	211.12P
Dec 1979	317.0P	–

P = Preliminary
R = Revised since last month

(1) Australian Bureau of Statistics, Canberra; "Price Index of Materials Used in Manufacturing Industry" (Catalogue No. 6411.0), Table 3.

(2) Australian Bureau of Statistics, Canberra; "Wage Rates, Australia" (Catalogue No. 6312.0), Table 1. Figures for the latest twelve months shown are subject to revision.

(3) Monthly data for 1970 through 1978 appear on pages 4.7 and 4.8 of Report No. 138, dated January 31, 1980.

STATISTICAL DATA

REPUBLIC OF SOUTH AFRICA STATISTICS

	Average Declared Working Costs per Metric Ton of Gold Ore Milled (Rand)(1)	Consumer Price Index(2) (1975 = 100, except where otherwise indicated)
Annual Avg. 1970(3)	7.34	100.3(4)
Annual Avg. 1971(3)	7.88	106.4(4)
Annual Avg. 1972(3)	8.79	113.3(4)
Annual Avg. 1973(3)	10.51	124.1(4)
Annual Avg. 1974(3)	13.18	138.5(4)
Annual Avg. 1975(3)	16.71	157.2(4)
Annual Avg. 1976(3)	19.30	174.7(4)
Annual Avg. 1977(3)	23.87	194.4(4)
Annual Avg. 1978(3)	27.14	137.2
Annual Avg. 1979(3)	30.18	155.3
Jan 1979	–	145.3
Feb 1979	–	146.1
Mar 1979	28.60	148.6
Apr 1979	–	149.9
May 1979	–	150.6
Jun 1979	29.44	152.4
Jul 1979	–	157.9
Aug 1979	–	160.2
Sep 1979	30.71	162.1
Oct 1979	–	162.9
Nov 1979	–	163.4
Dec 1979	31.89	164.0
Jan 1980	–	165.4
Feb 1980	–	167.0

(1) Chamber of Mines of South Africa, Johannesburg; "Analysis of Working Results," published quarterly.

(2) Republic of South Africa Department of Statistics, Pretoria; "Government Gazette: Consumer Index for Urban Areas."

(3) Historical data for 1970 through 1979 appear on page 4.9 of Report No. 140 of April, 1980.

(4) April 1970 = 100.00

STATISTICAL DATA

REPUBLIC OF SOUTH AFRICA STATISTICS

Average Declared Working Costs per Metric Ton of Gold Ore Milled (Rand)[1]

Quarter Ending	1979	1978	1977	1976	1975	1974	1973	1972	1971	1970
March	28.60	26.70	23.02	18.51	15.64	11.98	9.39	8.49	7.65	7.28
June	29.44	26.19	23.19	19.06	16.40	12.60	10.29	8.66	7.84	7.32
Sept	30.71	27.41	23.85	19.39	17.05	13.73	10.95	8.83	7.91	7.34
Dec	31.89	28.23	25.37	20.25	17.69	14.41	11.36	9.17	8.12	7.43
Annual Average	30.18	27.14	23.87	19.30	16.71	13.18	10.51	8.79	7.88	7.34

Consumer Price Index – Urban Areas[2]

Month	1979	1978	1977	1976	1975	1974	1973	1972	1971	1970
	(1975 ann. avg. = 100)		(. . . . . . . April 1970 = 100 for 1970 through 1977 . . . .)							
Jan	145.3	130.2	183.8	166.0	149.0	129.3	118.7	109.6	102.7	–
Feb	146.1	131.3	186.7	166.8	150.4	131.1	119.8	110.0	102.8	–
Mar	148.6	131.9	188.7	168.8	151.4	133.2	121.5	110.5	103.6	–
Apr	149.9	133.0	190.5	170.9	153.5	134.0	122.3	111.0	105.1	100.0
May	150.6	133.6	191.7	172.6	154.7	134.8	122.9	111.8	105.8	100.1
Jun	152.4	134.2	193.3	174.1	156.7	137.2	123.4	112.2	106.5	100.4
Jul	157.9	139.8	195.4	175.6	158.3	139.2	124.3	113.2	107.1	100.8
Aug	160.2	140.6	197.9	177.8	159.9	141.5	125.0	114.4	107.5	101.1
Sep	162.1	141.8	199.5	179.3	161.0	143.5	126.1	115.8	108.0	101.6
Oct	162.9	142.6	200.7	180.5	162.4	144.7	127.4	116.6	108.7	102.1
Nov	163.4	143.1	201.7	181.0	163.9	146.0	128.5	116.6	109.0	102.1
Dec	164.0	143.8	202.6	182.4	164.6	147.3	129.1	117.4	109.4	102.3
Annual Average	155.3	137.2	194.4	174.7	157.2	138.5	124.1	113.3	106.4	100.3

(1) Chamber of Mines of South Africa, Johannesburg; "Analysis of Working Results," published quarterly.

(2) Republic of South Africa Department of Statistics, Pretoria; "Government Gazette: Consumer Price Index for Urban Areas."

MARKET OPPORTUNITIES

Market Opportunities are *active* inquiries in the uranium market to buy, sell, borrow or lend. The data presented in this section are in no way intended to be indicative of the entire uranium market for the time period covered.

SUPPLY

Nuexco Reference Number	**Delivery Period (Thousands of Pounds U_3O_8)**				**Remarks**
	1980	**1981**	**1982**	**1983**	
Uranium Available for Sale:					
1213	1000				
1236	200	200	200		
1274	150	800	800		
1284	250				
1286	350	150	150	150	
1306		100	200	200	
1315			200	200	
1324		500	500	500	
1325	750				
1333	350	250	250		
1338	250				
1345	50				
1346	100				
1377	50				
1392	200				
1394	100				
1395	250				
TOTALS	4050	2000	2300	1050	
Uranium Available for Loan:					
1136	1000				UF_6
1136A	350				
1175	700				UF_6
1234	700				
1354	600				UF_6
1355	600				
1383	1000				
TOTAL	4950				

MARKET OPPORTUNITIES

DEMAND

Nuexco Reference Number	Delivery Period (Thousands of Pounds U_3O_8)				Remarks
	1980	1981	1982	1983	
Inquiries to Purchase:					
1146		100	200	200	
1260		800			
1321			400	400	
1335	500				
1357		300			
1380	400				
1381	100				
TOTALS	1000	1200	600	600	
Inquiries to Borrow:					
1220	1000				
1348	350				
TOTAL	1350				

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NUEXCO

MONTHLY REPORT ON THE URANIUM MARKET

NO. 141

MAY 1980

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EXECUTIVE SUMMARY & INDUSTRY OVERVIEW
NUEXCO REPORT NO. 141

The **Exchange Value** dropped again this month to \$32 per pound U_3O_8, from \$35 last month. It has decreased a total of \$8 over the last three months. The liquidation of uranium inventory by users continues to contribute to the price decline. However, this is just a symptom of the underlying problem—there is much more uranium being produced in the world than is being consumed. (Nuexco defines consumption as uranium entering the enrichment-fabrication pipeline for later use in a reactor.) In 1979, world production was about 30 million pounds U_3O_8 in excess of consumption. The same is expected in 1980. Although the gap is expected to begin closing after 1980, the cumulative world excess of production over consumption for the years 1979 through 1983 is estimated by Nuexco to be about 135 million pounds U_3O_8. This is notwithstanding a downward revision of Nuexco's estimated world production, which reflects the current weak uranium market.

The revised estimate of world production is included in the **General** section of this Report. The biggest changes from the last Nuexco estimates, published in Reports 133 and 134, are in US production. Due to weakening prices, Nuexco now expects US production to decline from its present level.

Spot market activity slowed during April. There was a substantial gap between bids and offers during most of the month, so few transactions were actually concluded. Uranium available for sale in 1980 was about double that sought through inquiries. Most of the current inquiries in the near-term market are from producers.

Falling price has increased the marketing difficulties faced by **Australian** sellers, as the spot price approaches the minimum levels set by their government when prices were both higher and more stable.

The status of nuclear power in several nations in **Europe** and the **Far East** is reviewed in this Report.

A *Commentary* section is introduced in this Report. This month's commentary deals with the subject of national decision making.

The *Raw Materials* section concludes a two-part series on uranium occurrence in quartz-pebble conglomerates. This month's discussion focuses on the Witwatersrand district of **The Republic of South Africa** and the Elliot Lake district of **Canada**.

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5/80

NUEXCO

MONTHLY REPORT ON THE URANIUM MARKET

No. 141 May 1980

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FOREWORD ii

THE URANIUM MARKET
- GENERAL 1.0
  - Estimate of World Uranium Production 1.0
- AFRICA 1.5
- AUSTRALIA 1.5
- EUROPE 1.5
- FAR EAST 1.6
- UNITED STATES 1.7
- PRICING 1.9

COMMENTARY
- NATIONAL DECISION MAKING 2.0

RAW MATERIALS
- QUARTZ-PEBBLE CONGLOMERATES—PART II 3.0

STATISTICAL DATA
- EXCHANGE AND TRANSACTION VALUES 4.0
- LOAN USE CHARGE RATE 4.3
- CURRENT TRANSACTIONS 4.4
- OPTIMUM TAILS ASSAY 4.5
- GOVERNMENT STATISTICS 4.6

MARKET OPPORTUNITIES
- SUPPLY 5.0
  - Uranium Available for Sale
  - Uranium Available for Loan
- DEMAND 5.1
  - Inquiries to Purchase Uranium
  - Inquiries to Borrow Uranium

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FOREWORD

Nuexco hosted a luncheon at the AIF Fuel Cycle Conference in New Orleans on April 16. Bob Wolcott and Jim Vaughan of the Nuexco staff delivered some comments on the current state of the uranium market. Copies of their remarks are enclosed with this Report.

In this Report, we are introducing a *Commentary* section. This month's commentary is on the subject of national decision making.

URANIUM MARKET

GENERAL

Estimate of World Uranium Production

Nuexco presented estimates of US and world production of U_3O_8 in Reports 133 and 134. Those estimates were developed under the assumption that the economics of uranium production would remain relatively favorable. Since that time, the uranium market has substantially weakened. That decline in the market has been especially severe on uranium producers in the US, where average production costs for many producers is at or above the current Exchange Value.

Under the conditions prevailing in today's uranium market, it is unlikely that projects not yet under construction will go forward. Consequently, Nuexco has prepared an estimate of world uranium supply based only on facilities which are operating or under construction as of April 30, 1980. In the US, some existing facilities have begun to reduce production. Some can be expected to suspend production within the next one to three years if present trends continue. The estimate of US uranium production presented in this Report is based upon Nuexco's assessments of the probable output of each producer, which in turn is based upon estimated production cost, ore reserves, and sales commitments.

Production centers are divided into categories, according to stage of development, as follows:

1. Operating production centers—those which have shipped U_3O_8 in commercial quantities before May 1, 1980.
2. Production centers under construction—those which were being built as of May 1, 1980, and which have an established access to ore reserves. Conventional production centers are included in this category only if mill construction has actually begun.

Each category is further divided, according to source, as follows:

—Conventional milling
—Unconventional recovery methods
  - Solution mining, including *in situ* leaching and hydraulic mining.
  - Phosphoric acid by-product recovery.
  - Heap leaching, including leachings of tailings and copper dumps.

Operating US production centers are listed in Table 1. Centers under construction are listed in Table 2. Table 3 summarizes the estimated U_3O_8 production for each category. The annual totals through 1986 constitute Nuexco's current judgment of output from the US uranium production sector. Estimates are also included for 1990 as indicators of production which can be foreseen today.

Actual US uranium production was about 37 million pounds U_3O_8 in 1979, falling short of Nuexco's previous estimate by one million pounds. The difference is largely attributable to an unanticipated decline in mill utilization. Annual US production from existing facilities is expected to decline from the 1979 level of 37 million pounds U_3O_8 to about 23 million pounds in 1986. The decrease is due to declining ore grades, depletion of orebodies and production cutbacks due to high costs. Total US production is expected to be 27 million pounds in 1986.

Since Nuexco Report 133 was published, four production centers have begun operating (all unconventional) and three have begun construction. However, three unconventional production facilities have since terminated operations and several conventional mills have reduced daily throughput of ore below rated capacity.

Non-US production centers included in this estimate are listed in Table 4. Conventional production facilities are included only if the mill is operating or under construction. Table 5 tabulates estimated world uranium production by region; Table 6 contains the same production estimates segmented according to status of the production center. World production for 1979 totalled approximately 99 million pounds U_3O_8, of which non-US production accounted for 62 percent. Table 5 shows the US portion of the world's uranium production declining steadily from its present level of 38 percent.

Table 1
OPERATING US PRODUCTION CENTERS

CONVENTIONAL MILLS

- Anaconda Corp.; Grants, NM
- Atlas Minerals Corp.; Moab, UT
- Chevron Resources; Pannamaria, TX
- Conoco-Pioneer Nuclear JV; Falls City, TX
- Cotter Corp; Canon City, CO
- Dawn Mining Co.; Ford, WA
- Exxon Minerals Co. USA; Powder River Basin, WY
- Federal American Partners; Gas Hills, WY
- Kerr-McGee Nuclear; Grants, NM
- Pathfinder Mines Corp.; Gas Hills, WY
- Pathfinder Mines Corp.; Shirley Basin, WY
- Petrotomics Co.; Shirley Basin, WY
- Rio Algom Corp.; La Sal, UT
- Rocky Mountain Energy; Bear Creek, WY
- Sohio-Reserve; Seboyeta, NM
- Union Carbide Corp.; Uravan, CO
- Union Carbide Corp.; Gas Hills, WY
- United Nuclear Corp.; Church Rock, NM
- United Nuclear-Homestake Partners; Grants, NM
- Western Nuclear, Inc.; Jeffrey City, WY
- Western Nuclear, Inc.; Sherwood, WA

UNCONVENTIONAL SOURCES

Solution Mining:

- Kaneb Assoc.-Everest Exploration; Hobson, TX
- Mobil Oil Corp.; Holiday El Mesquite, TX
- Mobil Oil Corp.; Bruni, TX
- Uranium Resources Corp.; Bruni, TX
- Uranium Resources-Framco-Conoco JV; Benevedes, TX
- US Steel Corp.; George West, TX
- US Steel-NM Uranium; Clay West, TX
- Wyoming Mineral Corp.; Iragary, WY
- Wyoming Mineral Corp.; Bruni, TX
- Wyoming Mineral Corp.; Ray Point, TX

Phosphoric Acid By-product:

- Freeport Uranium Recovery Corp.; Uncle Sam, LA
- Gardinier, Inc.; Tampa, FL
- IMC Corp.; New Wales[1]
- Wyoming Mineral Corp.; @Farmland Industries, Pierce, FL

Heap Leaching:

- Anamax Mining Co.; Sahuarita, AZ
- Solution Engineering, Inc.; Falls City, TX
- Union Carbide Corp.; Maybell, CO
- Wyoming Mineral Corp.; Bingham, UT

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[1] Start-up phase in progress. Scheduled to commence commercial operations May 1980.

Table 2
US PRODUCTION CENTERS UNDER CONSTRUCTION

CONVENTIONAL MILLS

- Bokum Resources; Marquez, NM
- Energy Fuels; Blanding, UT
- Minerals Exploration; Sweetwater, WY
- Plateau Resources; Shootering Canyon, UT

UNCONVENTIONAL SOURCES

Solution Mining:

- Mobil Oil Corp.; Nell, TX
- Mobil Oil Corp.; Piedre Lumbre & Brelum, TX

Phosphoric Acid By-product:

- Earth Sciences; Calgary, Alberta[2]
- Freeport Uranium Recovery Corp. @ Agrico; Faustina, LA
- IMC Corp. @CF Industries; Plant City, FL
- IMC Corp. @CF Industries; Bartow, FL

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[2] P_2O_5 is made from US phosphate rock, so U_3O_8 recovered is deemed to be of US origin.

Table 3
ESTIMATED US URANIUM PRODUCTION
(millions of pounds U_3O_8)

	1979	1980	1981	1982	1983	1984	1985	1986	1990
Operating:									
Conventional Mills	33.4	29.5	26.7	25.7	24.2	21.0	20.9	19.0	18.5
Unconventional Sources	3.6	5.6	5.9	6.3	5.8	5.3	5.0	4.0	3.8
Subtotal	37.0	35.1	32.6	32.0	30.0	26.4	25.9	23.0	22.3
Under construction:	—0—	0.7	2.4	2.9	3.4	3.8	3.6	3.8	3.8
TOTAL (rounded to nearest million)	37	36	35	35	33	30	29	27	26

Table 4
OTHER PRODUCTION CENTERS
(outside Communist areas)

Country	**Status**	**Operating Company (Deposit)**
Australia	OP	Mary Kathleen Uranium (Mary Kathleen)
	OP	Queensland Mines Ltd. (Nabarlek)
	UC 82	Ranger Uranium Mines (Jabiru)
Canada	OP	Denison Mines, Ltd. (Elliot Lake)
	OP	Eldorado Nuclear, Ltd. (Beaverlodge)
	OP	Gulf Minerals Canada (Rabbit Lake)
	OP	Madawaska Mines, Ltd. (Bancroft)
	OP	Rio Algom, Ltd. (Quirke)
	OP	Rio Algom, Ltd. (Panel)
	UC 81	Amok, Ltd. (Cluff Lake)
	UC 83	Rio Algom, Ltd. (Stanleigh)
Gabon	OP	Comuf (Oklo, Mounana)
Namibia	OP	Rossing Uranium, Ltd. (Rossing)
Niger	OP	Cominak (Akouta)
	OP	Somair (Arlit)
Republic of South Africa	OP	Blyvooruitzicht
	OP	Buffelsfontein
	OP	Chemwes
	OP	ERGO
	OP	Harmony
	OP	Hartebeestfontein
	OP	JMS
	OP	Nuco
	OP	Palabora
	OP	Randfontein
	OP	Vaal Reefs
	OP	Western Deep Levels
	OP	West Driefontein
	OP	West Rand Consolidated
	UC 81	BEISA
	UC 83	Western Areas
	UC 83	Afrikander Lease

OP = Operating as of May, 1980.
UC__ = Mill under construction as of April 30, 1980 and production is anticipated in the year indicated.

Table 5
ESTIMATED URANIUM PRODUCTION
(millions of pounds U_3O_8)

	1979	1980	1981	1982	1983	1984	1985	1986	1990
Australia	1.8	2.3	3.8	4.3	6.9	9.3	9.1	9.1	9.1
Canada	17.5	19.0	20.9	21.6	21.6	23.1	24.6	24.6	24.6
Republic of South Africa	12.5	15.1	18.5	19.4	20.2	20.7	21.1	21.5	21.5
Other Africa	21.8	23.7	26.8	27.8	29.6	31.6	31.6	31.6	31.6
Other Nations[3]	7.9	9.2	11.1	11.6	11.9	11.9	12.4	14.0	14.0
Non-US total (rounded to nearest million)	62	69	81	85	90	97	99	101	101
US	37	36	35	35	33	30	29	27	26
Total: World Outside Communist Areas	99	105	116	120	123	127	128	128	127

[3] Includes Argentina, Brazil, France, Mexico, Spain and others, but does not include Communist areas.

Table 6
ESTIMATED URANIUM PRODUCTION*
(millions of pounds U_3O_8)

	1979	1980	1981	1982	1983	1984	1985	1986	1990
Operating:									
US	37.0	35.1	32.6	32.0	30.0	26.4	25.9	23.0	22.3
Non-US	61.5	69.1	76.5	78.3	80.1	82.1	82.1	83.0	82.8
Subtotal	98.5	104.2	109.1	110.3	110.1	108.5	108.0	106.0	105.1
Under Construction:									
US	—0—	0.7	2.4	2.9	3.4	3.8	3.8	3.8	3.8
Non-US	—0—	0.3	4.4	6.4	10.2	14.7	16.8	17.8	17.8
Subtotal	—0—	1.0	6.8	9.3	13.6	18.5	20.6	21.6	21.6
Total	99	105	116	120	124	127	129	128	127

*Outside Communist areas.

AFRICA

First quarter 1980 uranium production for the **Republic of South Africa** is set forth in Table 7. Total production is ten percent higher than the last quarter of 1979, and 46 percent higher than the first quarter of 1979, one year ago. South African production continues to increase as new production capacity is added. The plant expansions at Harmony are nearly complete, and the extended JMS plant is now operating at its rated capacity. Western Deep Levels will also complete a capacity expansion this year. The production figure for Vaal Reefs includes about 22,000 pounds U_3O_8 representing the initial production from Afrikander Lease. Output from the Afrikander Lease mine will continue to be treated at Vaal Reefs until the Afrikander Lease production center is completed.

Table 7
REPUBLIC OF SOUTH AFRICA
FIRST QUARTER 1980 PRODUCTION

	Thousands of Pounds U_3O_8
Blyvooruitzicht	195
Buffelsfontein	337
Chemwes (Stilfontein)	372
ERGO	170
Harmony	250
Hartebeestfontein	222
JMS	461
Palaborwa	63
Randfontein	328
Vaal Reefs	967
West Driefontein	153
West Rand Consolidated	200
Western Deep Levels	105
TOTAL	3,823

AUSTRALIA

Falling price has increased the marketing difficulties faced by Australian sellers. Their principal problem is that near-term market prices are nearing the minimum levels determined by the Australian government at a time when prices were stable and higher. At the time, the spread between market price and the government-mandated minimum levels was such that the Australian sellers had a good deal of flexibility in structuring their sales proposals, which provided incentive to buy Australian uranium. Under current market conditions, however, the spread has narrowed dramatically.

The Australian government has given no indication that it will alter its position in those commercial areas it considers important. However, it has been reported that Ranger will sign a long-term contract with a US utility this month. The terms of such a contract will have to be approved by the Australian Uranium Export Office following signature. If the contract is, in fact, signed and approved, it should provide a new benchmark for commercial terms acceptable to the Australian government.

EUROPE

The **French** government is intensifying its efforts to reduce the nation's dependence on imported oil by increasing the portion of electricity generated by nuclear power. In 1979, nuclear power produced about 16 percent of total electric power generation. The aim is to increase this figure to 50 percent by 1985. With 24 reactors now under construction, and construction to begin on ten more by the end of 1981, Electricité de France (EdF) expects to bring a new unit on line every two months. According to EdF, as of January 1980, a kilowatt-hour of nuclear generated electricity in France cost 40 percent less than coal generated electricity, and 60 percent less than oil.

In the **Federal Republic of Germany**, the utility industry association, VDEW, estimates that additional nuclear power requirements, over and above those plants already operating, will be 23,200 MWe by 1990. There are ten units currently under construction, totaling 10,900 MWe. Most of these units should be on line by 1985. Also, Kraftwerk Union was recently selected to supply the second Ohu unit (1,200 MWe) in Bavaria. However, there will still be a substantial shortfall below the VDEW target for 1990, with a corresponding drop in economic growth, if additional nuclear unit orders are not placed soon. Many in the FRG fear that the nation's lack of strong commitment to nuclear power will put German industry at a competitive disadvantage vis à vis countries—such as France—which derive their energy supplies to a greater extent from relatively more cost-effective nuclear power.

URANIUM MARKET

Final government approval has been granted for the construction of two gas-cooled nuclear plants in the **UK**. The plants are part of a British plan to order one nuclear plant per year during 1982-91. Scheduled to come on line in 1986 and 1988, the plants (1,300 MWe each) will increase Britain's nuclear power generated share of electricity from its current 13 percent to more than 20 percent.

The **Swiss** project Energie Nucléaire Kaiseraugst (ENK), the target of fierce anti-nuclear opposition, is preparing a project report for presentation to the Swiss Parliament in late 1980 which could be critical to the entire Swiss nuclear program. If parliamentary approval of the project is not given, the Swiss anti-nuclear opposition will likely be encouraged to co-operate in blocking future projects. The principal contractors for the ENK project have halted design work, pending the parliamentary ruling.

In the **USSR**, installed nuclear capacity at the end of 1979 was approximately 11,300 MWe. Of the many nuclear plants scheduled to begin operating in 1979, only four actually did. The USSR's first PWR, Novo-Voronezh unit 5, a 1,000 MWe plant which is the prototype for a series of plants, was unable to start on schedule due to sealing problems in the primary coolant pumps. In early April, the 600 MWe fast breeder reactor (FBR) at Beloyarsk delivered power —about 200 MWe—into the Russian grid for the first time. The unit is currently the largest FBR in operation in the world. The USSR plans to build several larger (1,600 MWe) units of the same type.

Elsewhere in the Eastern bloc, eight nuclear units now operating in **Bulgaria**, the **German Democratic Republic** and **Czechoslovakia** have a combined installed capacity of about 3,000 MWe.

Finland's state power company, Imatran Voima Osakeyhtio, will purchase a third unit for its Loviisa site from Techsnabexport of the USSR. The 1,000 MWe PWR is modeled after the Novo-Voronezh unit 5 in the USSR.

FAR EAST

In September 1979, Nuexco published a Special Topical Report on **Japan** entitled, *Uranium Supply and Demand in Japan*. That report presented an overview of Japan's nuclear program as a basis for understanding its uranium procurement policy. In the past six months, developments in Japan suggest that, despite technical, political, social and environmental problems, the Japanese nuclear program continues to progress.

—Fukushima I unit 6 (1,067 MWe), owned by Tokyo Electric Power Company (Tepco), and Ohi unit 2 (1,122 MWe) owned by Kansai Electric Power Company, were successfully started up.

—TEPCO has completed environmental evaluation of two additional 1,100 MWe units at its Kashiwazaki site and is soon expected to ask for government approval as "officially planned" projects. TEPCO is also understood to be considering plans for two additional 1,100 MWe units at a new site on the Shimokita peninsula at the northern end of Honshu.

—Hokuriku Electric Power Company has announced plans to proceed with its initial nuclear plants—two medium-sized BWRs to be located at Noto.

—Tohoku Electric Power Company is evaluating the feasibility of a nuclear unit for its Maki site.

All of these new plants will be operational by the late 1980's or early 1990's. Although the Japanese government has revised its official target downward to 28,000 MWe operational by 1985, Nuexco now estimates that 22,000 MWe is a more realistic figure for that year.

The Japanese have also continued to move forward in a variety of other areas, including:

—Evaluation and planning for a large, commercial advanced thermal reactor.

—Solution of the technical and non-proliferation problems, allowing the re-starting of the small, No. 1 reprocessing plant.

—Establishment in March 1980 of the Japan Nuclear Fuel Service Company to own and operate the 1,200 ton/year No. 2 reprocessing plant, which is scheduled for operation in the early 1990's.

—Organization of a new private company by four major nuclear manufacturers to proceed with detail design work on a 300 MWe fast breeder.

—Development by Asahi Chemical, with government support, of an ion-exchange enrichment technology with a pilot plant scheduled for 1983 operation.

The range of activity, involving both the private and government sectors, is indicative of Japan's strong and continuing commitment to nuclear power.

On the uranium side, there are growing indications that the Japanese utilities are preparing for a renegotiation of the prices applicable to the 1980 and 1981 deliveries under their long-term uranium supply agreements. Although these prices, reportedly settled in the range of $44 to $46 per pound U_3O_8, were originally established by negotiation only last year, weakening market conditions have made them a growing embarrassment to the utilities.

As Phase I of its program to diversify energy sources, **Taiwan** is carrying out an ambitious expansion plan to complete 5,144 MWe of nuclear capacity, or 36 percent of the country's electric power generation capability, by 1985. The construction of coal-fired plants is also being accelerated; the current plan calls for coal, nuclear power and oil to generate about one third each of Taiwan's electricity by 1987. Table 8 shows Taiwan's nuclear power program to the year 2000.

Table 8
NUCLEAR POWER PROGRAM IN TAIWAN

	Number of Units	Size (MWe)	Incremental Installed Capacity (MWe)
Phase I (by 1985)	6	600/900	5,144
Phase II (1988-1993)	6	900	5,400
Phase III (1994-2000)	8	1,200	9,600

The **Peoples Republic of China** has renewed its interest in proceeding with nuclear power. A nuclear plant near Canton is now under consideration. Part of the output of the plant is expected to be sent to Hong Kong.

UNITED STATES

The second post-TMI limited operating license was issued to Virginia Electric and Power Co. for North Anna unit 2. A third limited operating license was issued to Public Service Electric & Gas Co. for Salem unit 2. These licenses allow loading of fuel and criticality, but not generation of electric power. Additional approvals will later be required for testing at five percent of rated power. There still have been no authorizations for power ascension since the Three Mile Island accident. Eleven US nuclear units, in addition to the three already licensed for zero power testing, are virtually complete and await only authorization by the US NRC to begin operating.

International Minerals & Chemical Corporation (IMC) has begun operation of its new commercial uranium recovery facility adjacent to its New Wales phosphoric acid plant near Mulberry, Florida. The uranium plant, the largest uranium-from-phosphate facility in the world, is currently in the start-up phase, and is progressing on schedule toward commercial operation later this month.

The plant's total uranium output could exceed two million pounds per year. This figure includes recovery of uranium processed from phosphoric acid from all of IMC's Florida plants, as well as from the nearby Bartow and Plant City phosphate operations of CF Industries. IMC has a 12-year agreement with CF Industries to extract uranium from the phosphate streams of its two plants.

Figure 1 is an aerial view of the New Wales facility, with the uranium extraction operation in the lower right quadrant.

Only one of the original 17 utility disputes with Westinghouse Electric Corp. remains in litigation, that of Long Island Lighting Co. South Carolina Electric & Gas Co. has settled with Westinghouse, but the terms of the settlement have not been announced. However, it is now possible to make a general assessment of the revised Westinghouse uranium situation. Table 9 summarizes Nuexco's estimate of the uranium involved in the utility settlements with Westinghouse. The original court-ordered allocations are included in the totals. In three of the settlements (Duquesne Lighting Co., Southern Services Co., and the Tennessee Valley Authority), there was no additional uranium involved other than the original allocations. Only the amounts involved in the original allocations are included for South Carolina Electric & Gas Co. and Long Island Lighting Co. Table 10 summarizes Nuexco's estimate of the total annual delivery obligations under the Westinghouse settlements.

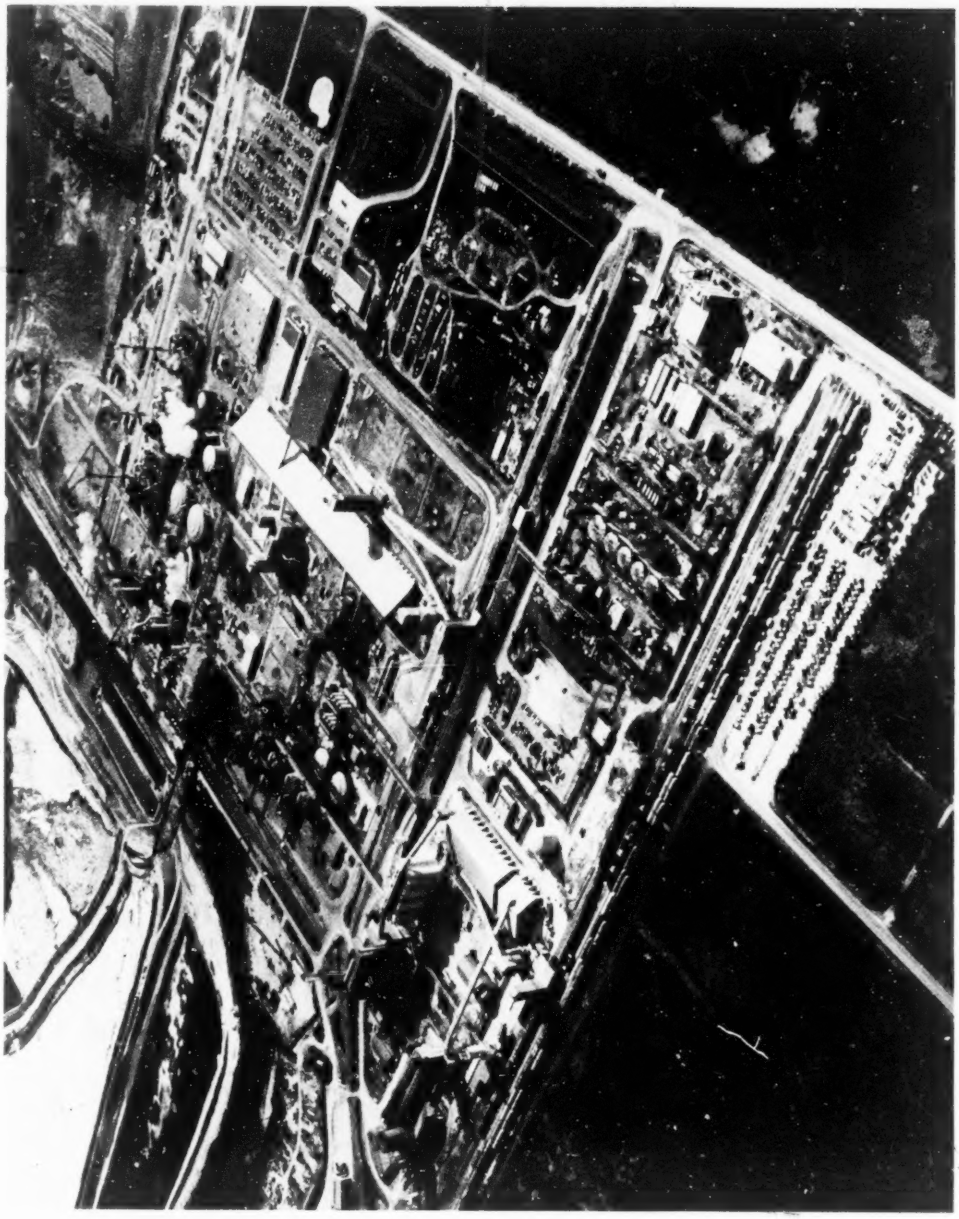


Figure 1
IMC'S NEW WALES PHOSPHORIC ACID PLANT NEAR MULBERRY, FLORIDA, SHOWING THE URANIUM RECOVERY FACILITY IN THE LOWER RIGHT QUADRANT.

Table 9
ESTIMATED QUANTITIES OF URANIUM INVOLVED IN WESTINGHOUSE SETTLEMENTS
(thousands of pounds U_3O_8)

Utility	Quantity Originally in Dispute[1]	Settlement Quantity[1,2]
Consolidated Edison	2,500	2,200
Duquesne (Capco)	700	100[3]
Florida Power & Light	3,600	1,700
Kansas Gas & Electric	4,000	2,400
Long Island Lighting	9,000	1,600[4]
Northeast Utilities	2,700	2,000
South Carolina Electric & Gas	4,000	800[4]
South Texas Project	10,500	8,700
Southern Services	800	100[3]
Sweden: Sydkraft SSPB OKG	5,000	3,800
Tennessee Valley Authority	3,600	600[3]
Texas Utilities	2,900	1,200
Union Electric	10,200	6,200
Virginia Electric Power	13,800	9,900
Wisconsin Electric Power	2,600	1,900
TOTAL:	75,900	43,200

---

[1] Quantities are rounded to nearest 100,000 pounds.
[2] Including original court-ordered allocation.
[3] No uranium other than original court-ordered allocation was included in settlement.
[4] Does not include South Carolina Electric & Gas Co. and Long Island Lighting Co. except to the extent of the original court-ordered allocation.

Table 10
ESTIMATED TOTAL ANNUAL DELIVERIES UNDER WESTINGHOUSE SETTLEMENTS[1]
(thousands of pounds U_3O_8)

Year	Quantity
1976	5,000
1977	2,300
1978	2,200
1979	2,300
1980	3,600
1981	1,600
1982	1,900
1983	1,100
1984	1,400
1985	1,900
1986	2,400
1987	2,400
1988	2,400
1989	2,400
1990	1,900
1991	2,000
1992	1,500
1993	1,300
1994	1,300
1995, etc.	2,300

[1] Does not include South Carolina Electric & Gas Co. and Long Island Lighting Co., except to the extent of the original court-ordered allocation.

PRICING

The **Exchange Value** decreased again this month to \$32.00 per pound U_3O_8, a drop of nine percent from the previous month.

The pace of activity in the spot market was somewhat reduced. Through most of April, there appeared to be a substantial spread, often several dollars per pound, between bids and offers. Thus, few transactions were actually concluded. However, near the end of the month, it appeared that some sellers were willing to reduce offer prices to close to bid levels in order to complete sales. This explains the large drop in Exchange Value.

Uranium available for near-term sale, as tabulated in the *Market Opportunities* section of this Report totals about 3.75 million pounds U_3O_8, down about 300,000 pounds from last month. Near-term inquiries to purchase uranium total 1.9 million pounds U_3O_8, up 900,000 pounds from last month. Most of the potential buyers for near-term delivery are producers. If prices continue to be weak, other producers have indicated that they might enter the market as buyers. That is, they might purchase material on the spot market to resell under long-term contracts, rather than produce the materials themselves.

Expressed in constant dollars, the Exchange Value has been dropping for some time. Figure 2 represents the Exchange Value expressed in constant dollars, using the Producer Price Index—Industrial Commodities, to adjust for inflation. The *real* price of uranium, expressed in today's dollars, has fallen from $60 per pound U_3O_8 in early 1976 (when the Exchange Value first reached $40) to $32, a decrease of almost a factor of two.

Price weakness is, of course, only a reflection of the basic problem—uranium production has outstripped, and continues to outstrip, consumption. As a consequence, inventories in the hands of users have continued to grow. Current inventories average two and one half to three years forward consumption. However, the utilities' perceived *need* for inventory has declined at a time when lack of timely rate relief and record interest rates have made even the maintenance of current inventory levels extremely expensive.

Inventory policy considerations should not, however, obscure the basic reason for the current price weakness; more uranium is being produced than consumed. Table 11 compares world uranium production with consumption for the years 1979 through 1983. The consumption estimates (defined as uranium entering the enrichment-fabrication pipeline for ultimate use in a reactor) in Table 11 are from Nuexco Report 140. The production estimates are from Table 6 of this Report. Annual production exceeds annual consumption by an average of more than 25 million pounds for each year in Table 11.

Thus, while it is clear that user liquidation of inventories has provided some of the impetus to the fall in uranium price over the past few months, it is only a symptom of a longer-term oversupply problem in the uranium market.

Table 11
WORLD URANIUM PRODUCTION AND CONSUMPTION
(millions of pounds U_3O_8)

Year	World Production[1]	World Consumption[1]
1979	99	69
1980	105	70
1981	116	88
1982	120	96
1983	123	104

[1] Does not include Communist areas.

URANIUM MARKET

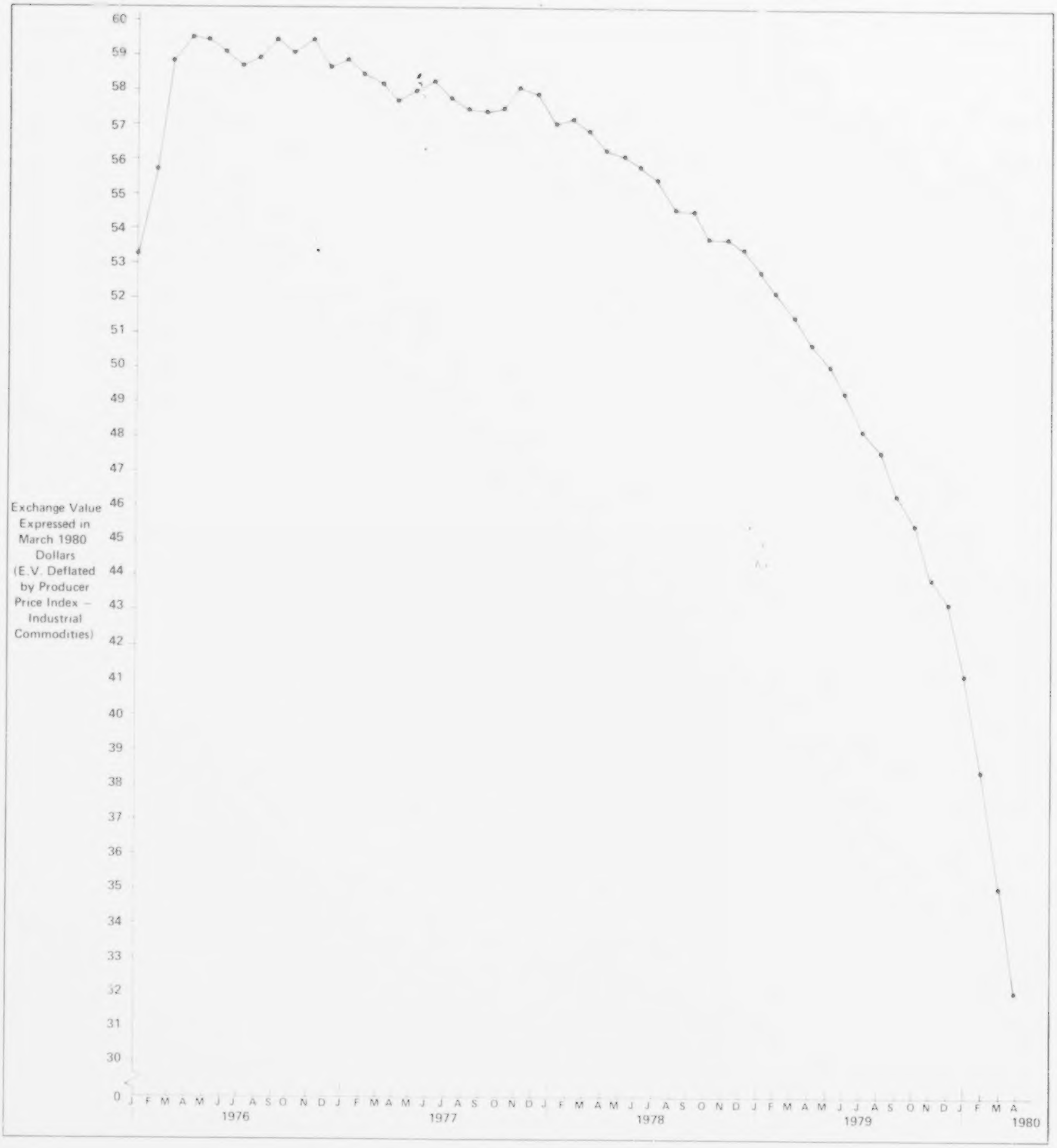


Figure 2
EXCHANGE VALUE EXPRESSED IN CONSTANT DOLLARS

COMMENTARY

NATIONAL DECISION MAKING

> *I believe that the 1980's will be a decade of decisions. The decisions will be difficult, painful, and they will require sacrifices. There are obvious problems such as energy and inflation that we must come to grips with. It is also probable that in this decade we will have to revamp the health care system in the United States and come up with alternative transportation systems for the United States.*
>
> *As I think of these issues and others, I think they have important characteristics in common. First of all, each one is vastly more complex than Three Mile Island. Second, each requires significant technical input from a variety of sources, such as scientists, engineers, medical scientists, economists, and many other sources. Third, these problems cannot be solved piecemeal, they require a systems approach. Fourth, these problems can only be solved on a national scale. Fifth, in order to implement any of these plans there will have to be a substantial national consensus to make the sacrifices acceptable. Finally, a clear decision will have to be made on the issues by the President and Congress. Currently, I do not see a process in plan to achieve these goals.*
>
> Dr. John G. Kemeny

Dr. Kemeny, President of Dartmouth College and Chairman of the Kemeny Commission on Three Mile Island spoke before the Commonwealth Club of San Francisco on March 28, 1980. His subject was a critique of national decision making. The above quotation is an excerpt from his remarks.

The thrust of Dr. Kemeny's remarks was that "our present system simply does not work, at least not with the decisions that involve science and technology" and "the only way to save it (democracy) is to make a fundamental change in the entire process of national decision making." Nuclear power was only one problem. Health care, transportation and many other technical areas are in equal difficulty.

He found in the TMI investigation that "the work of 100 well-known scientists and that of one dissenter will get equal treatment by the media;" that "emotions are having an overwhelming influence on the judgment of scientists," and "they have become advocates instead of useful advisers." He found that Congressmen made technical judgments rather than value judgments, while technical experts were asked to make value judgments rather than technical judgments.

Dr. Kemeny stressed that ours is an advanced society dependent on technology. Only a rational national decision-making process can deal with technical matters in a political environment. The fate of democracy, in Dr. Kemeny's view, may hang in the balance.

The views of such a distinguished, informed citizen should not go unheeded. But what can be done? It is obvious that two fundamental corrections have to occur:

1. Scientists must return to rendering objective judgments which do not allow for emotions to take precedence.
2. Legislators, public, bureaucracy and others must be able and willing to rely upon those technical assessments for value judgments.

Debasement of philosophical thought has been in process for years. Corruption in political thinking has not only been accepted, but often admired. Corruption has now become part of scientific thinking as judgments are warped to serve political ends.

The trend has favored an increasing reliance on the perceptual level, i.e. appealing to the senses. The unique human capabilities for conceptual thinking, i.e. integration of knowledge, and rational thinking have been subordinated. Thus we are encouraged to increase our reliance upon the level at which animals operate, and to decrease reliance upon human intellect.

Nuclear power has probably suffered most among modern technologies. Emotion dominates in the nuclear power debate. Most of the appeals we see are appeals to the senses. Rock concerts, as one example of total irrelevancy, may play as important a role as scientific argument.

An interpretation of Dr. Kemeny's message is that unless the nation can learn to cope successfully with nuclear power in our complex environment, we will not be able to solve problems in transportation, health services, and other important matters which rely upon technology. Ralph Nader and friends promised to contribute to society by converting nuclear power into a "technological Vietnam." Unless, as Dr. Kemeny says, we make a "fundamental change in the entire process of national decision-making," we may help Mr. Nader surpass his fondest hopes by producing a "democratic Armageddon."

RAW MATERIALS

QUARTZ-PEBBLE CONGLOMERATES—PART II

Introduction

Uranium produced from quartz-pebble conglomerates has been limited to the Witwatersrand and Elliot Lake districts. Production from each district was inspired by the large military requirements of Great Britain and the United States in the early 1950's. Mining activity created world-wide interest in quartz-pebble conglomerates. Several important discoveries have since been made, but none to equal those in either of the above districts. The details of the exploration and/or mine development in each district are reviewed in the following text.

Witwatersrand District, South Africa

The Witwatersrand sedimentary system is important to the Republic of South Africa for two reasons. It represents the world's most important source of gold, and it is the Republic's most important source of recoverable uranium, by far. The mining of gold from the conglomeratic reefs of the Witwatersrand System began about one hundred years ago. The existence of uranium was first noted in the gold ores about 1915, but it was not until 1923 that the uranium mineral was identified as uraninite. The Government Metallurgical Laboratory began an evaluation to determine the recoverability of uranium from gold ore in 1945.

Research proved that uranium could be recovered as a by-product of gold mining. A pilot system for the recovery of uranium began operating late in 1945, and successfully produced uranium concentrate for the next several years. A larger recovery system was installed in the milling circuit at the Blyvooruitzicht gold mine and mill complex near Carletonville in 1949. The first full-scale uranium mill circuit was built at Randfontein Estates in the West Rand mining district in 1952. The new industry expanded rapidly, and by 1957, there were 24 uranium recovery plants operating, with a total annual production of more than 10 million pounds U_3O_8.

The advent of commercial nuclear power in the mid-1960's created new interest in uranium, and production began to increase again. Several new recovery plants were constructed to meet the demand. However, by 1975 the price of gold had increased, leading to the mining of lower-grade ores, with an accompanying decrease in uranium production (gold and uranium content of ore are compatible and tend to vary in about the same ratio—see Part I of this article, Nuexco Report 140, for discussion of the genesis of the ore deposits contained in the Witwatersrand conglomerate). The same situation exists today as a result of increasing gold prices.

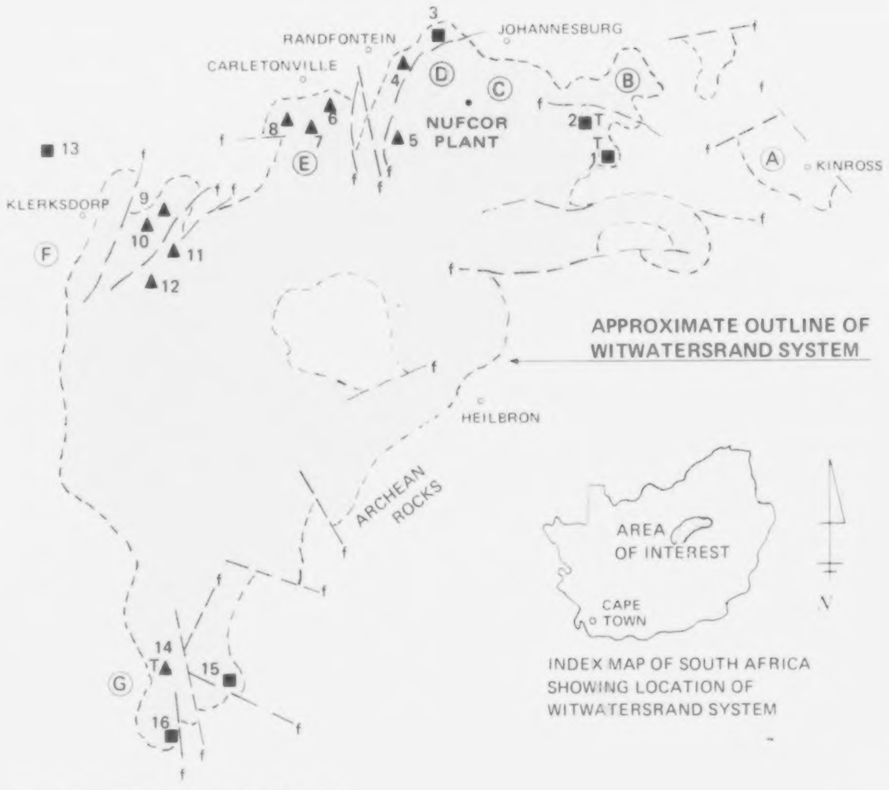
Uranium production has gradually increased since 1975. There are presently ten mines recovering uranium as a by-product of gold mining and one such recovery facility is under construction. Uranium is recovered as the primary mineral in four additional operations, with two others under construction. Two of the primary uranium producers are reworking old mill tailings to recover uranium along with gold. One mine in South Africa recovers uranium as a by-product of copper mining. Uranium production totaled 12.5 million pounds U_3O_8 in 1979. It is expected to total about 15.1 million pounds in 1980. Figure 3 is a map of the Witwatersrand district showing the location of the various mining areas and the current uranium recovery operation.

Economically recoverable amounts of uranium and/or gold have primarily been mined from a number of conglomeratic reefs in the upper 8,500 feet of the Lower Witwatersrand division and the basal 5,400 feet of the Upper Witwatersrand division. The combined thickness of the entire metasedimentary series is estimated to be approximately 25,000 feet toward the center of the synclinal basin. Most of the mines are located along the northern rim and southern tip of the basin, where mining depths vary from less than 2,000 feet to more than 12,000 feet.

The lower division of the Witwatersrand System consists of alternating shales, quartzites and quartz-pebble conglomerates. The basal unit is the Hospital Hill Series, which contains few, if any, conglomerates and no known economically recoverable occurrences of uranium or gold.

The Government Reef Series, which overlies the Hospital Hill Series, is about 6,500 feet thick and contains at least three mineralized reefs. The Promise and Bonanza Reefs are a source of gold only in the Central Rand and Klerksdorp districts, respectively. The Red Bluff Reef is near the top of the Government series, and is mined for uranium with gold produced as a by-product, in the Klerksdorp district.

The upper portion of the Lower Witwatersrand division is the Jeppestown Series consisting of almost 3,700 feet of conglomerates, shales and quartz-


3
RANDFONTEIN
JOHANNESBURG
CARLETONVILLE
4
D
C
B
NUFCOR PLANT
2
T
1
8
6
7
5
E
13
A
KINROSS
KLERKSDORP
9
10
11
12
F
f
APPROXIMATE OUTLINE OF WITWATERSRAND SYSTEM
HEILBRON
ARCHEAN ROCKS
AREA OF INTEREST
CAPE TOWN
N
14
T
15
G
16
INDEX MAP OF SOUTH AFRICA SHOWING LOCATION OF WITWATERSRAND SYSTEM

Approximate Scale: one inch = 30 miles

EXPLANATION

MINING DISTRICT

- Ⓐ – EVANDER
- Ⓑ – EAST RAND
- Ⓒ – CENTRAL RAND
- Ⓓ – WEST RAND
- Ⓔ – FAR WEST RAND
- Ⓕ – KLERKSDORP
- Ⓖ – FREE STATE

URANIUM PRODUCTION

- ■ – PRIMARY MINERAL PRODUCED
- ▲ – BY-PRODUCT OF GOLD
- T – RECOVERY FROM TAILINGS

SYMBOLS

- f – FAULT
- ○ – CITY

PRODUCTION CENTER INDEX

1. NUCO*
2. ERGO*
3. WEST RAND CONSOLIDATED*
4. RANDFONTEIN/COOKE SECTION
5. WESTERN AREAS (under construction)
6. WEST DRIEFONTEIN
7. WESTERN DEEP LEVELS
8. BLYVOORUITZICHT
9. CHEMWES (STILFONTEIN)
10. HARTEBEESTFONTEIN
11. BUFFELSFONTEIN
12. VAAL REEFS
13. AFRIKANDER LEASE* (under construction)
14. JOINT METALLURGICAL SCHEME
15. HARMONY*
16. BEISA* (under construction)

*Uranium is primary mineral produced.

Figure 3
WITWATERSRAND URANIUM/GOLD DISTRICT, SOUTH AFRICA

ites. No mining is carried out in the Jeppestown. However, the upper 200 feet of the series represent the depositional transition zone between the Lower and Upper Witwatersrand divisions. Erosional lows within the series are known to be filled with minable reefs which are correlated to the Upper division.

In the Klerksdorp district, mining has progressed into the Dominion Reef, which is below the Lower division of Witwatersrand. The Dominion Reef is the oldest sedimentary series in the basin and is in unconformable contact with highly-eroded Archaen rocks. The Dominion Reef System consists of about 9,000 feet of volcanics, quartzites and conglomerate reefs, at least two of which contain economically recoverable values of both uranium and gold. In a highly-faulted portion of the Klerksdorp district, the Witwatersrand System is in contact with the Dominion Reef. In this area, the Upper and Lower portion of the Dominion Reef System are mined for uranium. Gold is produced as a by-product. The two reefs are also mined for uranium on the Afrikander Lease.

The lower 3,300 feet of the Upper Witwatersrand division are commonly referred to as the Main-Bird Series and are of major importance for gold. The lower 700 feet of the series are comprised of the Main Reef Group, which contains four subordinate reefs. The Carbon Leader is the only uranium-bearing reef in the group. It is mined in the West and Far West Rand districts for gold and by-product uranium. Three other reefs, the North Reef, the Main Reef Leader and the South Reef, in ascending order, are important for gold content, but not uranium, in the Far West, West, Central and East Rand districts.

The Bird Reef Group of the Main-Bird Series is approximately 2,700 feet thick and contains four important uranium and gold-bearing reefs in the lower portion. The lowest is the Bird Reef, from which uranium is produced as the primary mineral in the West Rand district, with gold as a by-product. The next three reefs occurring in the ascending sequence are mined for gold, with uranium recovered as a by-product. They consist of the Basal Reef in the Orange Free State district, and the Leader Reef and the Vaal Reefs in the Klerksdorp district.

The uppermost 6,200 feet of the Upper division include the Kimberley-Elsburg Series which contains six ore-bearing reefs in the Kimberley Group and three in the Elsburg Group. The lowest reef in the Kimberley Reef Group is the Kimberly-B Reef. It is mined for uranium, with gold produced as a secondary mineral, in the Orange Free State district. Gold is the only mineral of importance in the Kimberly Reef and the Kimberley-A Reef, both in the Evander district. Gold and by-product uranium are recovered from the Kimberley Reef in the East Rand district. Only gold is recovered from the two upper reefs —the K9 Reef in the Central Rand district and the Battery Reef in the West Rand district.

The important reef in the Elsburg Group is the Middle Elsburg Reef in the West Rand district, which is mined primarily for uranium. Gold is mined from Individuals Reef in the Klerksdorp and Orange Free State districts. The uppermost reef in the group is the Massives, which is a gold-bearing reef in the West Rand district.

The Ventersdorp System overlies the Witwatersrand System. It consists of massive volcanic flows, quartzites and scattered quartz-pebble conglomerates. A thin layer of conglomerate occurs at the contact between the Witwatersrand System and the volcanic rocks of the Ventersdorp System. This reef is referred to as the Ventersdorp Contact Reef. It is an important source of gold in the West Rand, Far West Rand and Klerksdorp districts.

Generally, important reef series are correlated from district to district. However, reef groups are commonly found throughout neighboring districts, but not necessarily throughout the basin. The inconsistencies are attributable to a break-up in depositional patterns due to erosional surface features and the distance from the materials source area. Later metamorphism and structural development of the basin caused disruptions in continuity, especially in areas of major faulting, as in the Klerksdorp district. Controversy over correlation among the various reefs will persist as long as mining is carried out.

Elliot Lake District, Ontario, Canada

Uranium was first discovered in quartz-pebble conglomerates of the Huronian Formation near the northern shore of Lake Huron in 1948. A prospecting rush ensued and the outcrop area of the lower conglomeratic sequence of Huronian rocks was evaluated from Sault St. Marie eastward to Sudbury and northward to Quirke Lake. Many radiometric anomalies were located, but in almost every case, the percentage of U_3O_8 contained in the surface rock was too low to be mined. The first commercial-grade uranium was discovered during a test drilling program down-dip from a surface anomaly near the town of Blind River in 1952.

The discovery became known as the Pronto ore deposit. Another round of exploration activity followed. Five separate mineralized zones were discovered within the Huronian conglomeratic sequence. Of the five zones, the Quirke Lake and Nordic ore zones with ore values of one to four pounds U_3O_8 per ton, represent two of the largest uranium deposits known to occur in quartz-pebble conglomerates. The remaining three ore zones—the Whiskey, Pecors and Pardee contain lower grades, and have not yet been developed. Figure 4 shows the five ore zones and the location of mines and mills within the district.

The first ore deposit to be developed was the Pronto, which began production in early 1955. Less than four years later, 12 deep-shaft mines and 11 processing mills were operating on the Quirke and Nordic ore zones, at a production capacity of about 40,000 tons of ore per day. Elliot Lake had become the most important uranium district in Canada within ten years after uranium mineralization was first discovered.

The Huronian metasedimentary sequence is 10,000 feet thick, consisting of quartzites, argillites and arkose sand units interbedded with fine to coarse-grained conglomeratic beds. Uranium mineralization is confined to the conglomerate reefs in the basal Matinenda formation which is in unconformable contact with older crystalline rocks of Archean age. The depositional characteristics of the Elliot Lake reefs closely parallel those of the Witwatersrand Sequence. The most important difference is a lack of commercial amounts of gold in Elliot Lake deposits.

Huronian rocks have been folded to form an east-west trending syncline in the Elliot Lake district. The lower Matinenda conglomerates outcrop on both limbs of the syncline. It was along the outcrop area that anomalous radioactivity was first encountered, eventually leading to the five discoveries. The Quirke ore zone on the northern flank of the syncline is the largest ore deposit in the district. The deposit parallels the synclinal trend for about 35,000 feet, at widths varying from 6,000 to 10,000 feet. Minable ore depths vary from about 1,000 feet along the northern limits to over 3,500 feet in the south. The Nordic ore zone, which is located on the southern limb of the syncline, was the site of the first mine development in the area—the Buckles mine began ore production in late 1955. The Nordic zone extends northwest from the outcrop for about 20,000 feet, and has an average width of 5,300 feet. Depth to the ore zone averages about 1,500 feet. Ore thickness varies from 8-20 feet in the two ore zones.

Denison Mines Ltd. and Rio Algom Ltd. have produced uranium in the district since 1957. Denison controls a large portion of the Quirke ore zone, where all its activities are located. Production from the Denison mine has increased to about 9,500 tons per day from 5,000 tons per day in 1975. Denison has established a production goal of 21,000 tons per day for 1985. It has scheduled the rehabilitation of the Stanrock and Can-Met mining areas to attain the 1985 production goal. The processing mill located at the Denison mine is scheduled to be expanded to handle 15,000 tons of ore per day, up from the current rate of 7,100 tons per day. Total U_3O_8 production was about 4.5 million pounds during 1979. The expansion program was initiated by Denison in connection with a long-term sales contract with Ontario Hydro.

Rio Algom Ltd. controls the Quirke, New Quirke, Panel and Spanish American mines located on the Quirke ore zone. Mine production during 1979 was 7,000 tons ore per day; total U_3O_8 production in 1979 was 4.9 million pounds from the Quirke mine and mill complex. The Panel mine and mill were reopened in 1979 as part of Rio's expansion program. It contributed an additional 2,400 tons ore per day, and 390,000 pounds U_3O_8, bringing total Rio Algom 1979 production to 5.3 million pounds U_3O_8. Full production of 3,000 tons per day at the Panel mine is expected to be achived during 1981. In addition, Rio Algom has started renovation of the Stanleigh mine and mill located on the Nordic ore zone, in connection with a long-term agreement with Ontario Hydro. The mine is scheduled to produce at the rate of about 5,000 tons ore per day by 1983. Rio Algom is currently considering a plan to reopen the Milliken mine. It is also probable that the Lacnor and Nordic mine workings will be dewatered and the ore mined through the Milliken.

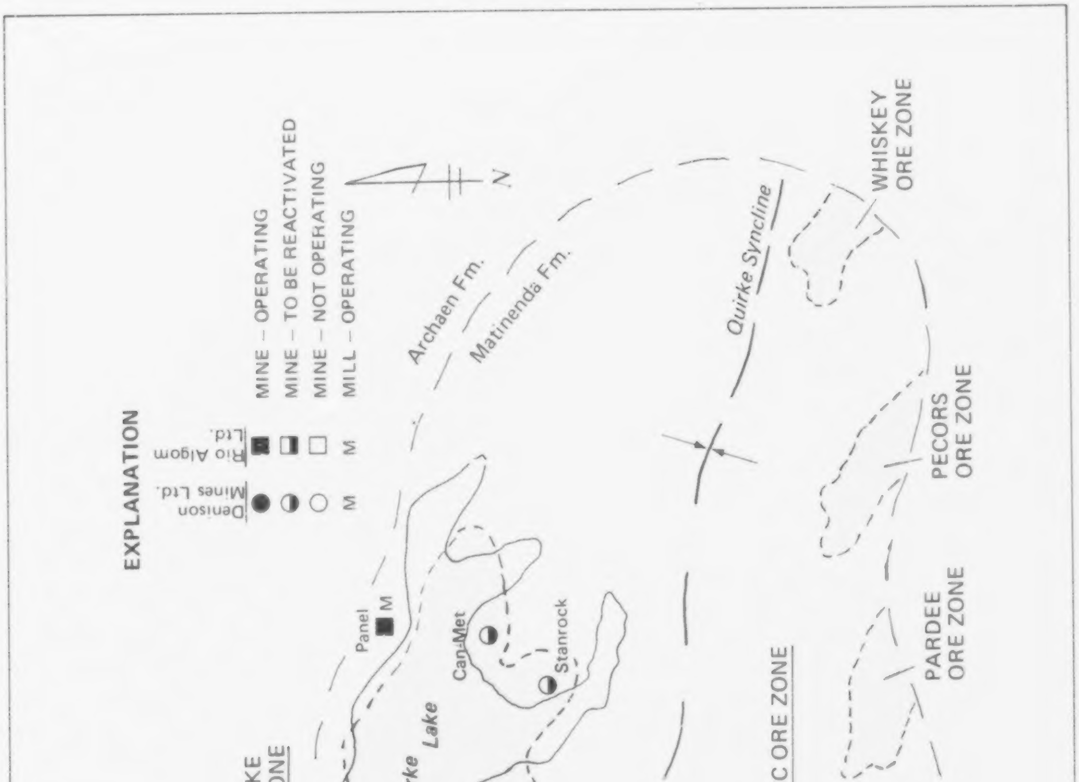

EXPLANATION
Denison Mines Ltd.
Rio Algom Ltd.
● ■ MINE – OPERATING
◐ ◧ MINE – TO BE REACTIVATED
○ □ MINE – NOT OPERATING
M M MILL – OPERATING
N
APPROXIMATE SURFACE OUTCROP OF HURONIAN CONGLOMERATIC SEQUENCE
Archaen Fm.
Matinenda Fm.
QUIRKE ORE ZONE
Quirke
M
New Quirke
Denison
M
Spanish American
Panel
M
Quirke Lake
Can-Met
Stanrock
Quirke Syncline
WHISKEY ORE ZONE
PECORS ORE ZONE
PARDEE ORE ZONE
NORDIC ORE ZONE
Stanleigh
Milliken
Lacnor
Nordic
Buckles (1st mine in area)
Elliot Lake
Approximate Scale: one inch = two miles

Figure 4
ELLIOT LAKE URANIUM DISTRICT
ONTARIO, CANADA

World Districts

Exploration activity for uranium in Early Proterozoic metasediments has been concentrated on quartz-pebble conglomerates because of depositional and mineralogic similarities to the Elliot Lake and Witwatersrand districts. Evaluation techniques used in prospective areas are modeled after the successful techniques applied at Elliot Lake and in the Witwatersrand. Several areas have been evaluated, but with limited success.

One of the most promising prospects at this time is in the vicinity of Jacobina, Bahia, in **Brazil**, where quartz-pebble congomerates occur on the periphery of a syncline within the limits of the São Francisco Archean complex. The area has been known as a gold district since the 17th century. Uranium has been associated with gold in the conglomeratic lenses or reefs, in the Serra do Corrego Formation of the Jacobina Series. Uraninite and gold mineralization is concentrated in the fine segment of the reef matrix. The reefs tend to be discontinuous throughout the strike-length of the outcrop area. They vary in thickness from a trace to about four feet, interbedded with quartzite. The formation is about 6,000 feet thick, with most reefs occurring well up in the section. The Piritoso and the Chahu reefs are the main gold and uranium-bearing reefs in the district. Uranium values average between 0.02% to 0.04% U_3O_8. Uranium is secondary in content to gold. Uranium resources in the district are not known.

Uranium and gold-bearing conglomerates occur in two other areas of the same district. Reefs form the basal part of the Moeda Formation of the Minas Series and Nova Lima Group of the Rio das Velhas Series in the vicinity of Belo Horizonte. In each case, the percentage of uranium present is too low for mining. Considerable exploration remains to be completed in each area.

Early Proterozoic conglomerates of interest in the **United States** are limited to the southern Lake Superior region and the Wyoming Province. The areas of interest in the Lake Superior region offer only limited potential for the occurrence of uranium in quartz-pebble conglomerates, due to the age correlation of the metasediments. The potential conglomerates occur with other sediments as fill in synclines upon an Archean surface. The oldest conglomerates in the district have been estimated to be 1,400 to 2,100 million years old, which is at least 200 to 400 million years younger than the youngest uraniferous reefs at Elliot Lake and Witwatersrand. The greatest potential is for gold. However, an unknown number of uranium "shows" have been discovered in the past.

The area of interest in the Wyoming Province consists of an eight-mile-thick section of highly contorted rocks within the Medicine Bow Mountains. The metasedimentary rock section is considered to be 1,700 to 2,500 million years and is subdivided into three ascending age groups—the Phantom Lake Metamorphic Suite, Deep Lake Group and the Libby Creek Group. The Phantom Lake Group is separated into lower and upper sections by an obvious unconformity. The unconformable surface is overlain by a uraniferous quartz-pebble conglomerate.

The Deer Lake Group is, in turn, subdivided into six formations. The Magnolia Formation makes up the basal unit. It contains a series of interbedded conglomerates, most of which are radioactive. The potential of the Magnolia Formation is secondary to the Phantom Lake Suite which, according to sample assays, contains up to 140 parts per million uranium on the outcrop. Formation characteristics are similar to those of known uranium-bearing reefs. Additional exploration of the formation is justified on this basis.

Radioactive quartz-pebble conglomerates and related metasediments are known to exist in the Sierra Madre Mountains of southcentral Wyoming and in the Hartville uplift near Lusk, Wyoming. The Black Hills uplift of South Dakota consists of a series of metasediments and metavolcanics containing radioactive segments. One segment, the Estes quartz-pebble conglomerate is radioactive, and has been age-dated at about 2,500 million years. It is considered to be a favorable exploration target for both uranium and gold.

Uraniferous metasediments of Early Proterozoic Age are known to occur in a number of other locations. Usually the basal unit, which is in unconformable contact with Archean rocks, is a quartz-pebble conglomerate with characteristics analogous to those in the Witwatersrand and Huronian depositional sequence. In Central Africa, uranium occurs in basal conglomerates which are in fault contact with Archean granite near Mounana, **Gabon**, and in the Kawere Conglomerate of the Tarkwa Sequence in

Ghana and the **Ivory Coast**. In **India**, the basal conglomerates of the Dharwar Sequence are of interest for both gold and uranium mineralization in the Precambrian shield areas of Karnataka, Singhbhum, and Aravalli. The Karelian Sequence (metasedimentary) in the **USSR** forms a potential mineral belt which extends northwest through **Finland** and **Sweden**. Uranium occurrences are known to occur along the trend of highly faulted and contorted rocks. Early Proterozoic metasediments crop out on the periphery of the Angara shield in Siberia. There are no reported occurrences of uraniferous conglomerates in the series, but the formation characteristics fit the Witwatersrand model. The potential of the area is favorable.

The Precambrian provinces of **Australia** fall into the same favorable category, due to rock characteristics and the wide distribution of uranium found in Middle Proterozoic rocks in the Northern Territory. Favorable exploration targets exist in the Fortesque Series of the Hamersley Basin, the Malmac Formation along the north edge of the Nabberu Basin, and the King Leopold Conglomerate in the Halls Creek district, all in Western Australia. The potential for Early Proterozoic uranium in the Pine Creek Geosyncline is greatly limited because the rocks are of marine origin rather than fluvial as at Witwatersrand and Elliot Lake.

STATISTICAL DATA

EXCHANGE VALUE—\$32.00/lb U_3O_8
Determined as of April 30, 1980

DEFINITION

The Exchange Value is Nuexco's judgment of the price at which transactions for significant quantities of natural uranium concentrates could be concluded as of the last day of the month.

DERIVATION

Nuexco bases the Exchange Value upon:

A. Data from recently completed transactions.
B. Data from pending transactions.
C. Firm bids to buy and firm offers to sell.
D. Prices purchasers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy, and prices sellers have expressed a willingness to accept, but for which Nuexco is not aware of firm offers to sell.

COMMENTS

Nuexco does not consider the following in determining the Exchange Value:

A. The price of uranium delivered or to be delivered under old contracts.
B. The price of uranium delivered in connection with contract renegotiations or other than arm's length transactions.

TRANSACTION VALUE
Determined as of April 30, 1980

\$/lb U_3O_8	Millions of Pounds	Number of Transactions	Number of Months
38.40	3.6	13	3

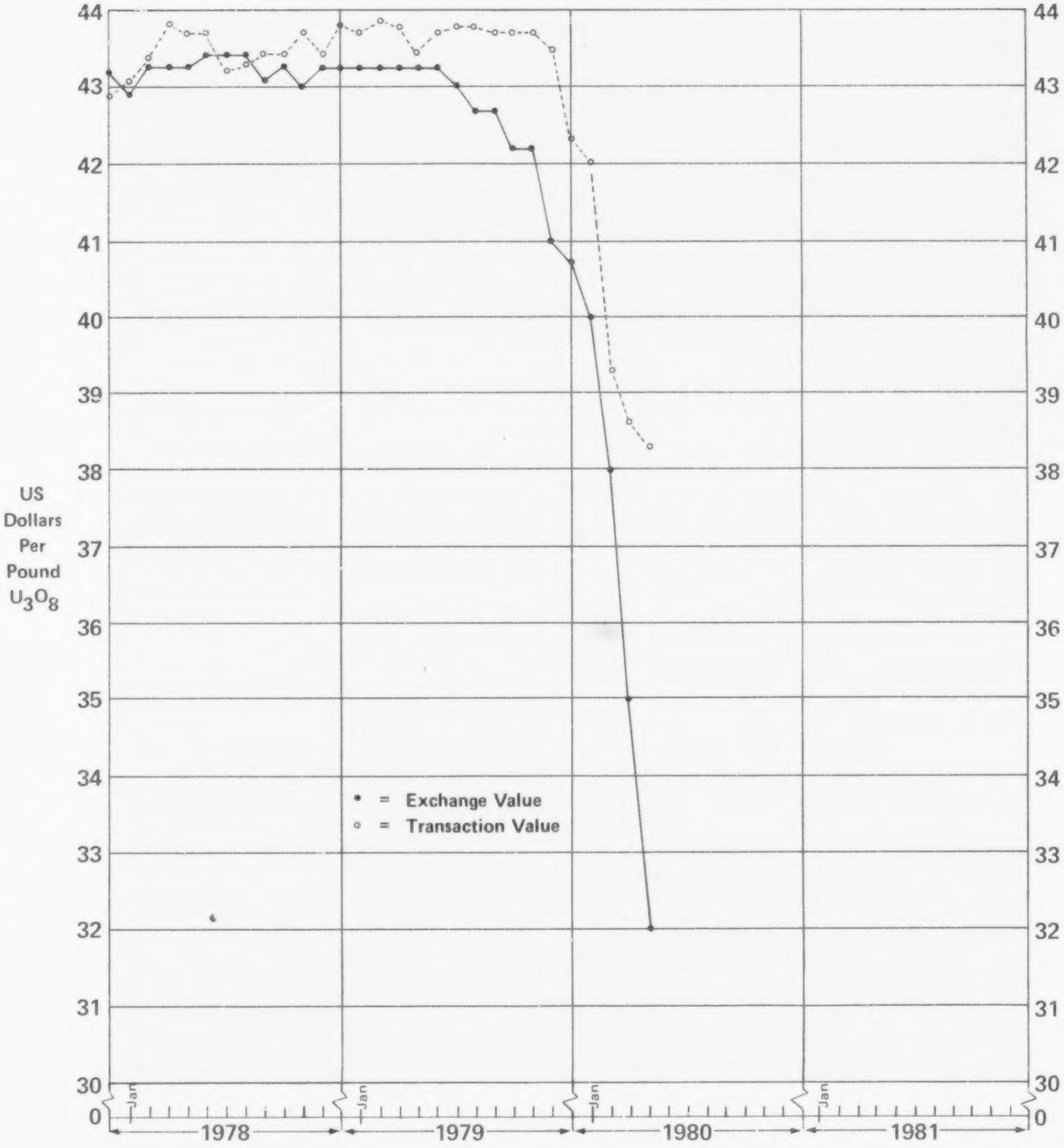
DEFINITION

The Transaction Value is a weighted average price of recent transactions, and is based on prices paid for U_3O_8 in transactions closed within the previous three-month period and for which delivery was scheduled within one year of the transaction date. At least ten transactions totaling at least two million pounds U_3O_8 are included in each calculation, or the sample time is extended as necessary to include these minima. Foreign currencies are converted to US dollars as of the transaction date.

STATISTICAL DATA

EXCHANGE AND TRANSACTION VALUES

Determined as of the last day of the month indicated



STATISTICAL DATA

HISTORICAL EXCHANGE VALUES

Determined as of the last day of the month indicated

(US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1968	–	–	–	–	–	–	–	6.35	6.35	6.40	6.45	6.50
1969	–	6.35	6.10	6.10	6.25	6.25	6.20	6.20	6.15	6.15	6.15	6.20
1970	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.20	6.15	6.15	6.15	6.15
1971	6.20	6.20	6.20	6.20	6.15	6.05	6.00	5.95	5.95	5.95	5.95	5.95
1972	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95
1973	5.95	6.00	6.10	6.20	6.45	6.50	6.50	6.50	6.50	6.50	6.75	7.00
1974	7.70	7.90	8.00	9.00	9.50	10.50	11.50	12.00	12.50	14.00	14.75	15.00
1975	16.00	16.00	18.00	20.00	21.00	23.00	24.70	26.00	26.00	28.50	30.00	35.00
1976	35.20	37.00	39.25	40.00	40.00	40.00	40.00	40.40	41.00	41.00	41.50	41.00
1977	41.35	41.50	41.60	41.60	42.00	42.25	42.25	42.25	42.40	42.75	43.20	43.20
1978	42.90	43.25	43.25	43.25	43.40	43.40	43.40	43.10	43.25	43.00	43.25	43.25
1979	43.25	43.25	43.25	43.25	43.25	43.00	42.70	42.70	42.20	42.20	41.00	40.75
1980	40.00	38.00	35.00	32.00								

Note: See earlier Nuexco Reports for evolution of the definition of Exchange Value.

HISTORICAL TRANSACTION VALUES

Determined as of the last day of the month indicated

(US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1976	–	–	–	–	39.60	39.70	39.70	40.40	40.30	40.60	40.70	40.70
1977	41.30	41.30	41.40	41.50	42.80	42.90	43.00	42.60	42.50	42.80	42.90	42.90
1978	43.10	43.30	43.70	43.60	43.60	43.20	43.30	43.40	43.40	43.60	43.40	43.70
1979	43.60	43.80	43.70	43.40	43.60	43.70	43.70	43.60	43.60	43.60	43.50	42.30
1980	42.00	39.30	38.60	38.40								

Note: See Nuexco Report 135 for a discussion of the definition of Transaction Value.

EXCHANGE VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES*

Country	per lb U_3O_8 in Concentrates	per kg U_3O_8 in Concentrates	per kg U in Concentrates
US (dollar)	32.00	70.55	83.19
France (franc)	135.48	296.68	352.21
FRG (mark)	58.03	127.94	150.88
Japan (yen)	7,804	17,206	20,290
Switzerland (franc)	54.24	119.57	141.00
UK (pound)	14.13	31.15	36.73
Australia (dollar)	28.87	63.64	75.05
Canada (dollar)	37.83	83.41	98.36
Niger, Gabon (CFA)	6,774	14,934	17,611
South Africa (rand)	25.76	56.97	66.97

*Calculated using currency exchange rates published in the Wall Street Journal on the last Friday of the month

LOAN USE CHARGE RATE — 7.0%/year

DEFINITION

The Loan Use Charge Rate is Nuexco's judgment of the annual interest rate at which uranium loans could be concluded as of the last day of the month.

DERIVATION

Nuexco bases the Loan Use Charge Rate upon:

A. Data from recently completed or pending loan transactions.
B. Rates included in firm proposals to borrow or lend.
C. Rates that potential borrowers and lenders have expressed a willingness to pay or accept, but for which Nuexco is not aware of firm proposals.

STATISTICAL DATA

CURRENT TRANSACTIONS*

Nuexco Reference Number	Delivery Period	Approximate Quantity (thousands of pounds, U_3O_8 equivalent)	Approximate Price as percent of Current E.V.	Seller Group	Buyer Group	Remarks
1099	80	Less than 50	114	US	Far East	UF_6
1105	80	300 to 600	—	US	Europe	Definitive price information not available
1110	80	100 to 300	101	US	US	

---

* Transactions listed include not only those in which Nuexco was involved, but also all others of which Nuexco is aware.

STATISTICAL DATA

OPTIMUM TAILS ASSAY

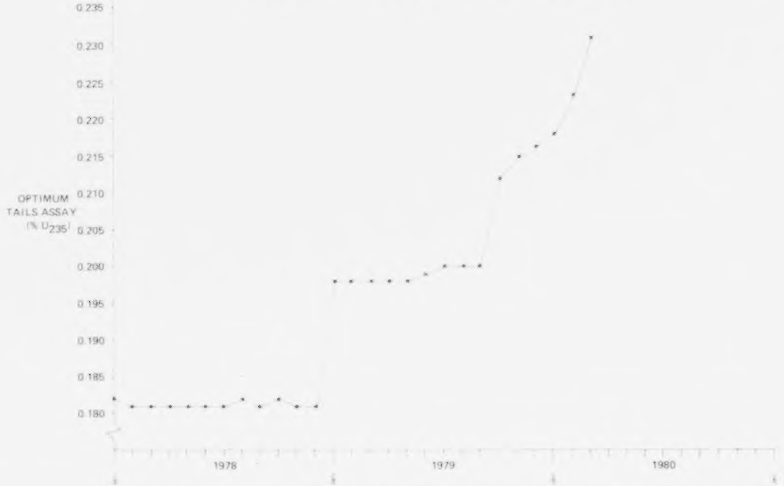
The optimum tails assay is the tails composition at which the cost of enriched uranium is lowest for given costs of separative work (SWU) and natural uranium feed. It depends only on the ratio of the cost of a kilogram of natural uranium in the form of UF_6 to the cost of a kilogram unit of separative work. The US Department of Energy (USDOE) Adjusted Fixed Commitment (AFC) enrichment contract holders have the option, within limits, to specify the transaction tails assay. The transaction tails assay for USDOE Requirements contracts is 0.20 percent U_{235}. For every one-hundredth of one percent increase in the transaction tails assay, uranium consumption increases about two percent.

TAILS ASSAY FOR MINIMUM COST OF PRODUCT*

Ratio of Unit Cost of Feed to Unit Cost of SWU

*From Nuexco Report 138

HISTORICAL OPTIMUM TAILS ASSAY†



†Based on Exchange Value and USDOE AFC SWU price, interpolated to the nearest thousandth

STATISTICAL DATA

US GOVERNMENT STATISTICS

	Producer Price Index—Industrial Commodities (1967 = 100)(1)	Consumer Price Index (1967 = 100)(2)	GNP Implicit Price Deflator (1972 = 100)(3)	Gross Average Hourly Earnings of Production or Non-supervisory Workers (US$)(4)		
				Metal Mining (SIC 10)	**Primary Non-ferrous Metals (SIC 333)**	**Chemicals and Allied Products (SIC 28)**
Annual Avg. 1970(5)	110.0	116.3	91.36	3.88	3.87	3.69
Annual Avg. 1971(5)	114.0	121.3	96.02	4.12	4.15	3.94
Annual Avg. 1972(5)	117.9	125.3	100.00	4.49	4.59	4.21
Annual Avg. 1973(5)	125.9	133.1	105.80	4.82	4.98	4.48
Annual Avg. 1974(5)	153.8	147.7	116.02	5.43	5.63	4.85
Annual Avg. 1975(5)	171.5	161.2	127.15	6.13	6.24	5.37
Annual Avg. 1976(5)	182.3	170.5	133.71	6.75	6.87	5.89
Annual Avg. 1977(5)	195.1(4)	181.5	141.70	7.28	7.67	6.43
Annual Avg. 1978(5)	209.4	195.4	152.05	8.23	8.56	7.01
Annual Avg. 1979(5)	236.3P	217.4	165.46	9.27	9.50	7.59
Jan 1979	220.0	204.7	–	8.71	9.01	7.32
Feb 1979	222.5	207.1	–	8.81	9.02	7.32
Mar 1979	225.4	209.1	160.22	8.84	9.11	7.36
Apr 1979	229.0	211.5	–	9.03	9.49	7.50
May 1979	231.6	214.1	–	9.06	9.15	7.47
Jun 1979	234.0	216.6	163.81	9.09	9.44	7.53
Jul 1979	237.5	218.9	–	9.32	9.57	7.60
Aug 1979	240.6	221.1	–	9.38	9.70	7.65
Sep 1979	244.2	223.4	167.20	9.63	9.79	7.73
Oct 1979	248.5	225.4	–	9.67	9.87	7.82
Nov 1979	250.2	227.5	–	9.79	9.86	7.87
Dec 1979	252.8	229.9	170.58	9.80R	9.92	7.91
Jan 1980	260.3	233.2	–	9.92	10.06	7.96
Feb 1980	265.4	236.4	–	9.91P	10.02P	7.99P
Mar 1980	268.2	239.8	–	–	–	8.05P

P = Preliminary   R = Revised since last month

(1) US Bureau of Labor Statistics, Washington, D.C.; "Producer Prices and Price Indexes," Table 6 (formerly "Wholesale Prices and Price Indexes"). Producer Price Indexes are revised four months after they are first released to reflect the availability of late reports and corrections by respondents.

(2) US Bureau of Labor Statistics, Washington, D.C.; Consumer Price Index for All Urban Consumers, US City Average, All Items.

(3) US Department of Commerce, Washington, D.C.; Bureau of Economic Analysis, National Income and Wealth Division; "Survey of Current Business," Table A. The GNP Implicit Price Deflator is published quarterly, and seasonally adjusted.

(4) US Bureau of Labor Statistics, Washington, D.C.; "Employment and Earnings," Table C-2. All data based on 1972 revision of SIC Manual. Data for 1970-1976 are adjusted to the March 1977 benchmark. All data for 1977 and beyond are adjusted to the most recent benchmark—March 1978—and are subject to revision from that point foward with the advent to the next benchmark scheduled for publication in late 1980.

(5) Data for these years, monthly except for the GNP Implicit Price Deflator, appear on pages 4.6 through 4.8 of Nuexco Report 139.

STATISTICAL DATA

AUSTRALIAN GOVERNMENT STATISTICS

	Price Index of Materials Used in Manufacturing Industry — All Groups (Year 1968-69 = 100.0)(1)	Weighted Average Minimum Weekly Wage Rates — Adult Males Australia Mining and Quarrying (A$)(2)
Annual Avg. 1970(3)	101.4	59.88
Annual Avg. 1971(3)	101.5	65.95
Annual Avg. 1972(3)	105.6	71.26
Annual Avg. 1973(3)	124.4	78.96
Annual Avg. 1974(3)	141.9	108.07
Annual Avg. 1975(3)	150.4	132.55
Annual Avg. 1976(3)	168.4	160.93
Annual Avg. 1977(3)	192.0	179.03
Annual Avg. 1978(3)	215.4	190.04
Nov 1978	232.2	190.86
Dec 1978	235.7	199.28R
Jan 1979	246.3	199.79R
Feb 1979	253.0	200.00
Mar 1979	264.0	201.45R
Apr 1979	273.0	202.27
May 1979	287.5	203.38R
Jun 1979	293.8	209.88R
Jul 1979	295.8	210.49R
Aug 1979	290.8	211.56
Sep 1979	300.0	212.34R
Oct 1979	307.0	211.80R
Nov 1979	308.0P	211.12
Dec 1979	317.0P	212.73P

P = Preliminary R = Revised since last month

(1) Australian Bureau of Statistics, Canberra; "Price Index of Materials Used in Manufacturing Industry" (Catalogue No. 6411.0), Table 3.

(2) Australian Bureau of Statistics, Canberra; "Wage Rates, Australia" (Catalogue No. 6312.0), Table 1. Figures for the latest twelve months shown are subject to revision.

(3) Monthly data for 1970 through 1978 appear on pages 4.7 and 4.8 of Nuexco Report 138.

CANADIAN GOVERNMENT STATISTICS

	Industry Selling Price Index: Manufacturing (D 500000)(1), (2) (1971 = 100.0)	Wage-earner Data: Average Hourly Earnings ($C)(3), (4)		
		Metal Mining, including milling (SIC 050-059)	**Primary Metal Industries, non-ferrous (SIC 296-298)**	**Chemicals and Chemical Products (SIC 370-379)**
Annual Avg. 1977	174.3	8.18	6.50	6.51
Annual Avg. 1978	190.4	8.76	6.82	6.97
Annual Avg. 1979	217.8	—	—	—
Dec 1978	199.4	9.29	6.93	7.14
Jan 1979	204.8	9.19	7.14	7.29
Feb 1979	208.5	9.24	7.18	7.36
Mar 1979	210.4	9.47	7.20	7.51
Apr 1979	212.8	9.68	7.26	7.63
May 1979	214.5	9.65	7.28	7.61
Jun 1979	216.0	9.49	7.27	7.66
Jul 1979	218.3	9.37	7.34	7.73
Aug 1979	220.0	9.56	7.38	7.77
Sep 1979	223.4	9.75	7.50	7.81
Oct 1979	227.4	9.89R	7.54	7.88
Nov 1979	228.1	9.97	7.61	7.91
Dec 1979	230.2R	9.93	7.51	7.89
Jan 1980	238.4	9.96P	7.62P	8.00P
Feb 1980	240.1P	—	—	—

P = Preliminary   R = Revised since last month

(1) Statistics Canada, Prices Division, Ottawa; "Industry Price Indexes" (Catalogue 62-011), Table 1. Indexes for the most recent six months shown are subject to revision.

(2) Monthly data for 1973 through 1978 appear on page 4.10 of Nuexco Report 138.

(3) Statistics Canada, Labour Division, Employment and Payrolls Section, Ottawa; "Employment, Earnings and Hours" (Catalogue 72-002), Table 2.

(4) Monthly data for 1977 and 1978 appear on page 4.11 of Nuexco Report 138.

REPUBLIC OF SOUTH AFRICA STATISTICS

	Average Declared Working Costs per Metric Ton of Gold Ore Milled (Rand)(1)	Consumer Price Index(2) (1975 = 100, except where otherwise indicated)
Annual Avg. 1970(3)	7.34	100.3(4)
Annual Avg. 1971(3)	7.88	106.4(4)
Annual Avg. 1972(3)	8.79	113.3(4)
Annual Avg. 1973(3)	10.51	124.1(4)
Annual Avg. 1974(3)	13.18	138.5(4)
Annual Avg. 1975(3)	16.71	157.2(4)
Annual Avg. 1976(3)	19.30	174.7(4)
Annual Avg. 1977(3)	23.87	194.4(4)
Annual Avg. 1978(3)	27.14	137.2
Annual Avg. 1979(3)	30.18	155.3
Jan 1979	–	145.3
Feb 1979	–	146.1
Mar 1979	28.60	148.6
Apr 1979	–	149.9
May 1979	–	150.6
Jun 1979	29.44	152.4
Jul 1979	–	157.9
Aug 1979	–	160.2
Sep 1979	30.71	162.1
Oct 1979	–	162.9
Nov 1979	–	163.4
Dec 1979	31.89	164.0
Jan 1980	–	165.4
Feb 1980	–	167.0
Mar 1980	–	168.0

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(1) Chamber of Mines of South Africa, Johannesburg; "Analysis of Working Results," published quarterly.

(2) Republic of South Africa Department of Statistics, Pretoria; "Government Gazette: Consumer Price Index for Urban Areas."

(3) Historical data for 1970 through 1979 appear on page 4.9 of Nuexco Report 140.

(4) April 1970 = 100.00

MARKET OPPORTUNITIES

Market Opportunities are *active* inquiries in the uranium market to buy, sell, borrow or lend. The data presented in this section are in no way intended to be indicative of the entire uranium market for the time period covered.

SUPPLY

Nuexco Reference Number	Delivery Period (Thousands of Pounds U_3O_8)				Remarks
	1980	1981	1982	1983	
Uranium Available for Sale:					
1213	700				
1236	100	100	100		
1274	150				
1284	250				
1286	350	150	150	150	
1306		100	200	200	
1315			200	200	
1324		500	500	500	
1325	750				
1333	350	250	250		
1338	250				
1346	100				
1377	50				
1392	300				
1394	250				
1403	150				
TOTALS	3750	1100	1400	1050	
Uranium Available for Loan:					
1136	1000				UF_6
1136A	350				
1175	700				UF_6
1234	700				
1354	600				UF_6
1355	600				
1383	1000				
TOTAL	4950				

MARKET OPPORTUNITIES

DEMAND

Nuexco Reference Number	Delivery Period (Thousands of Pounds U_3O_8) 1980	1981	1982	1983	Remarks
Inquiries to Purchase:					
1146		100	200	200	
1321			400	400	
1335	200				
1357		300			
1380	900				
1381	150				
1396	200				
1406	50				
1408	150				UF_6
1410		2000	2000	2000	
1412	250				
TOTALS	1900	2400	2600	2600	
Inquiries to Borrow:					
1220	1000				
1260	600				
1348	350				
1404	300				
TOTAL	2250				

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NUEXCO

JUNE 1980 NUMBER 142

Monthly Report on the Uranium Market

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EXECUTIVE SUMMARY & INDUSTRY OVERVIEW
NUEXCO REPORT 142

The **Exchange Value** remained at $32.00 per pound U_3O_8 for the month, stabilizing partly due to the return of lower interest rates and more plentiful loan money; as a consequence, some US utilities have reduced their efforts to sell uranium in inventory. Many potential buyers in the market continue to be producers, but it is significant that utilities are beginning to reappear as buyers. Some potential buyers believe the market has reached the bottom of its present decline, and hope to acquire material at attractive prices. The **Transaction Value** decreased to $37.90 per pound U_3O_8, from $38.40 the previous month.

The **General** section of this Report updates the supply demand balance analyzed earlier in Report 135. It is based on Nuexco estimates of apparent future consumption (Report 140) and future firm supply of uranium (Report 141). Delays and cancellations of reactor projects are combining with the apparently ample future availability of uranium to form an increasingly competitive market. High cost producers are likely to phase down operations, as low cost producers phase up. Although expanded production from Australia and western Canada is no longer *essential*, both countries will play a major role in the future market, due to their lower costs of production.

Spot market activity last month included four transactions involving US and Canadian sellers, and European and Far Eastern buyers.

The **British** Civil Uranium Procurement Organization has decided to not participate in the equity financing of Energy Resources of **Australia**. As with the prospective investors from **Japan** and the **FRG**, the British see less advantage in holding an equity position to ensure long-term security of supply during a period of weakening price, declining demand and perceived oversupply.

Australia's intent to develop enrichment capability received a boost when the **US** Department of Energy (USDOE) indicated interest in participating in a multi-national enrichment facility based in Australia.

The **People's Republic of China** has rekindled its interest in nuclear power. Plans for a 900 MWe unit near Canton are progressing; China Power & Light of **Hong Kong** will finance 40 percent of the plant's estimated cost and purchase 40 percent of its power.

USDOE's estimate of **US** uranium reserves as of January 1, 1980, increased slightly over last year's estimate.

The *Topical Essay* gives some perspectives on uranium inventory.

The *Raw Materials* section covers the **Republic of South Africa's** East Rand Gold & Uranium Company Limited (Ergo), which recovers gold and uranium from tailings of mining and milling operations.

This Executive Summary may be reproduced for internal distribution.

6 80

NUEXCO

MONTHLY REPORT ON THE URANIUM MARKET

June 1980 No. 142

MANAGING EDITOR:
JAMES E. VAUGHAN

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MICHELE-DANIELE V. PATIN

FOREWORD ii

THE URANIUM MARKET

GENERAL 1
  Supply and Demand Balance 1
AUSTRALIA 9
CANADA 9
EUROPE 9
FAR EAST 10
UNITED STATES 10
TRANSACTIONS 11
PRICING 11

TOPICAL ESSAY

SOME PERSPECTIVES ON URANIUM INVENTORY 13

RAW MATERIALS

EAST RAND GOLD AND URANIUM COMPANY LIMITED (ERGO) 16

STATISTICAL DATA

EXCHANGE AND TRANSACTION VALUES 22
LOAN USE CHARGE RATE 25
CURRENT TRANSACTIONS 26
OPTIMUM TAILS ASSAY 27
GOVERNMENT STATISTICS 28

MARKET OPPORTUNITIES

SUPPLY 32
  Uranium Available for Sale
  Uranium Available for Loan
DEMAND 33
  Inquiries to Purchase Uranium
  Inquiries to Borrow Uranium

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FOREWORD

We have implemented a number of format changes with this month's Report, including a different typeface and sequential page numbers. As always, Subscribers' comments are welcomed.

A new section on Optimum Tails Assay has been added to the Statistical Data section of the Report. The optimum tails assay will be calculated monthly, using the Exchange Value for the month along with the USDOE separative work price for fixed-commitment enrichment contracts.

Subscribers are reminded that the Exchange Value is available from all Nuexco Representatives after 8:00 a.m. San Francisco time on the first business day of the month.

URANIUM MARKET

GENERAL

Supply and Demand Balance

In Report 135, Nuexco published an analysis of world uranium supply and demand. The analysis concluded that:

1. *Firm supply* (defined as supply from uranium production centers operating or under construction) appeared more than sufficient to satisfy *consumption* (defined as uranium entering the enrichment-fabrication pipeline) on a worldwide basis through 1990.

2. In addition, firm supply appeared adequate to sustain a worldwide inventory level of approximately two years forward consumption.

Nuexco has re-estimated both apparent future consumption (Report 140) and future firm supply of uranium (Report 141). The resulting changes in the worldwide supply and demand balance are discussed below, following a few prefatory comments on computational groundrules and definitions.

1. Nuexco's estimates of apparent future consumption are sometimes confused with estimates of uranium burnup in reactors. Actually, apparent future consumption, as defined by Nuexco, is natural uranium concentrate which utilities will need to deliver in a given year for enrichment and fabrication and later use in a reactor. Thus, *consumption* is the fundamental component of uranium demand.

2. Anticipated future production from uranium production centers currently operating or under construction as of the date of the estimate is defined as *firm supply*.

3. The critical assumption in this supply-demand analysis is that uranium production centers in operation or currently under construction will be able to sell their projected U_3O_8 output, even if only for inventory accumulation in a time of apparent excess supply.

4. To the extent that actual annual demand exceeds consumption, inventory is accumulated.

5. Planned production centers—those with production plans and identified ore reserves, but for which construction has not yet begun—are not considered in this analysis under the definition of firm supply.

6. It is important to note that estimates of apparent future consumption take no account of reactors not yet ordered. Consequently, consumption estimates will understate actual demand by the amount attributable to orders yet to be placed, as well as by inventory purchases.

7. In order to facilitate understanding of the concept of apparent future consumption, Nuexco's methodology is summarized as follows:

a. Apparent future consumption should be regarded as a comparatively hard component of total demand, and is relatively insensitive to uranium prices. Market demand for the assumed pattern of additions to nuclear generating capacity can be higher, but is not likely to be much lower.

b. Actual demand can exceed apparent future consumption because of accelerated reactor construction schedules or inventory purchases by utilities.

c. Reactor loading is calculated for each reactor, based on its individual core characteristics. It is assumed that: 1) U_3O_8 deliveries for first cores predate commercial operation by two years; 2) first reload occurs 12 months after commercial operating date, and annually thereafter; 3) U_3O_8 delivery for each reload predates reload by 18 months.

d. Actual commercial operating dates can differ widely from published dates. Nuexco uses the best information available, much of it from unpublished sources.

e. These estimates make no provision for orders not yet placed. Only the consumption associated with reactors operating, under construction or on order is included.

f. Reactors fueled by the USSR are excluded.

8. Inventory refers to natural uranium inventory (U_3O_8 and UF_6) owned by utilities, reactor manufacturers, fuel fabricators and national organizations which procure uranium for commercial purposes. The inventory amounts do not include strategic stockpiles, such as those owned by the US Department of Energy (USDOE). Difficulties in accounting precisely for the variety of possible forms, locations and ownership of uranium inventory necessarily result in some uncertainty in estimating the total world natural uranium inventory. Nuexco's estimate of worldwide commercial natural uranium inventory as of the beginning of 1979 is approximately 160 million pounds; however, the uncertainty factor of this estimate is ten to fifteen percent. More important is the fact that the primary conclusions of this analysis are not sensitive to beginning inventory variations of ten to fifteen percent.

Analyses of the uranium supply and demand balance were conducted for each of the following

URANIUM MARKET

regions: (1) world outside Communist areas (WOCA); (2) US; (3) non-US WOCA.

Table 1 tabulates Nuexco's analysis of the uranium supply and demand balance for the world outside Communist areas (WOCA). Conclusions which may be drawn from the analysis include the following:

1. Firm supply exceeds consumption in each year through 1990, so supply and demand are balanced by additions to inventory. In actual practice, if supply exceeds demand over an extended period, the necessary balance would probably result from a combination of inventory purchases and reduced production.
2. The world inventory of 160 million pounds at the beginning of 1979 is equivalent to 2.3 years of forward consumption at the 1979 rate. The analysis indicates that inventory more than double, to approximately 400 million pounds U_3O_8 by 1990. That inventory corresponds to approximately 3.5 years forward consumption at the 1990 rate. This figure is in contrast to the data published just seven months ago in Nuexco Report 135. At that time, this same type of analysis indicated a fairly stable relative inventory level of 2.0 to 2.3 years forward consumption.
3. If actual demand is to be sufficient to support production from production centers planned, but not yet under construction, it may arise from new reactor orders, or from political or national policy considerations. However, it is more likely that the driving force behind any such additional production entering the market would be to supplant other higher-cost production centers.

Table 2 shows Nuexco's current analysis of the uranium supply and demand balance for the US. By treating the US alone, the potential market can be identified not only for imports, but also for potential US production centers not yet under construction.

The analysis in Table 2 is of the same basic form described above, but with the addition of an adjustment for *existing* US export-import commitments, as set forth in Table 3. The result is an annual supply surplus or deficit for the US. If the annual result is a supply surplus, it is assumed to have been added to buyer inventories. If the annual result is a supply deficit, it is assumed to have been removed from buyer inventories. The annual beginning and ending inventory levels are also tabulated in Table 2 along with the relative inventory level for that year, in years of forward consumption. Table 2 indicates the annual US supply deficit beginning in 1981 and growing to an annual level of 24 million pounds in 1990. Without additional imports or new US supply, US inventory would decline to a level equivalent to 18 months forward consumption by 1983. Under the groundrules of this analysis, US inventories would be completely liquidated in 1987.

Based on these results, it would appear that the US will be dependent to a large extent upon imported uranium by the mid-1980's. Thus it is likely that US users, as a group, will desire to maintain a commercial inventory of uranium. Tables 4 and 5 were developed under the assumption that US utilities would maintain a collective inventory level equivalent to at least 18 months forward consumption. The two most important assumptions in computing the data in Table 4 are as follows:

1. When, after taking into account exports, imports and annual consumption, annual US production is enough, or more than enough, to maintain inventory equivalent to 18 months forward consumption, any excess production will be added to inventory.
2. When, after taking into account exports, imports and annual consumption, annual US production is insufficient to maintain inventory equivalent to 18 months forward consumption, US buyers will acquire the additional uranium through some combination of increased imports, increased purchases from US facilities denoted as firm supply, and purchases from new US production centers not yet under construction.

If, as assumed in Table 4, US buyers maintain a minimum inventory level of 18 months forward consumption, an *unfilled US demand* would be created as follows (millions of pounds U_3O_8):

	1984	*1985*	*1986*	*1987*	*1988*	*1989*	*1990*
Annual	15.1	18.3	21.0	23.5	25.5	22.7	24.1
Cumulative	15.1	33.4	54.4	77.9	103.4	126.1	150.2

Thus, if US buyers' inventory policies take the form assumed in Table 4, the cumulative market for imports and new additions to US production will total approximately 150 million pounds U_3O_8 through 1990. This figure is substantially higher than in the previous Nuexco estimate, published in Report 136. The increase in *unfilled US demand* is primarily due to decreased Nuexco estimates in US *firm supply*. Thus it is likely that most of the uranium which would be needed to meet unfilled US demand will be imported.

Nuexco Report 136 contained the following paragraph which described the circumstance which would tend to increase the market for imports above the levels estimated in that Report:

> *Shifting economics may result in the premature closing of some US production listed as "firm supply." Although this analysis has accounted for estimated depletion of reserves, it is possible, perhaps even likely, that some operating production centers in the US will shut down prematurely due to unfavorable economics. The real price of uranium has been decreasing for about two years, and some US producers are expecting a cost squeeze which may make cutbacks necessary in economically marginal facilities. Since US production costs are generally higher than those of other uranium-producing nations, a prolonged buyers' market may tend to shift production out of the US.*

The situation described above has become more evident with the decline in the Exchange Value by more than 20 percent in the past six months. At the same time, increasing world inventory levels have heightened the possibility of a prolonged buyers' market. Consequently, Nuexco's estimate of US firm supply has decreased, and thus its estimate of unfilled US demand has increased substantially, to 150 million pounds U_3O_8, cumulative through 1990.

Other factors which would tend to further increase unfilled US demand above the current estimate are:

1. More export commitments will be made. This is not expected to be a major influence, but any new commitments to export uranium will increase the unfilled US demand estimate.

2. New reactors may be ordered. However, due to long construction lead times in the US, new reactors are not expected to add significantly to demand until after 1990.

If the US imports an additional 150 million pounds U_3O_8 through 1990, the effect on the rest of the world's uranium supply and demand balance could be substantial. Table 5 was developed to estimate this effect. Table 5 tabulates the supply-demand balance of the world outside the US and outside Communist areas, under the assumption that the US will import as necessary to maintain at least 18 months forward consumption in inventory. The analysis indicates an increase in relative inventory level from 2.8 years at the beginning of 1980 to more than 5 years by 1990. Even after projected exports to the US are deducted from firm supply, there is a substantial supply surplus in each year through 1990. This analysis shows inventories outside the US nearly tripling, from approximately 113 million pounds in 1980 to 320 million pounds in 1990.

Some general conclusions which may be drawn from this analysis are as follows:

1. Delays and cancellations of reactor projects combined with apparently ample future uranium availability are leading to an increasingly competitive uranium market.

2. Because the market is expected to be so competitive, the decade ahead is likely to be one in which high cost producers will phase down operations and low cost producers will begin phasing up.

3. The principal high cost producers are in the US. The principal low cost production potential is in Australia and western Canada. Whatever production capacity is added either to meet expanded demand, to compensate for depleting operations or to supplant production which becomes uneconomic will come largely from the latter areas.

4. While greatly expanded production from Australia and western Canada is no longer *essential* to fulfill world needs over the next decade, it remains clear that these areas will have a major future role because of their favorable economics of production.

5. Utility inventory policies will continue to be an especially important factor in determining the complexion of the uranium-producing sector during the 1980's.

Table 1

NATURAL URANIUM SUPPLY-DEMAND BALANCE: WOCA[1]

(millions of pounds U_3O_8)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
PRODUCTION[2]												
Operating Production Centers	98.5	104.2	109.1	110.3	110.0	108.5	108.0	106.0	105.3	105.1	105.1	105.1
Facilities under Construction	-0-	1.0	6.8	9.3	13.6	18.5	20.6	21.6	21.6	21.6	21.6	21.6
Firm Supply	98.5	105.2	115.9	119.6	123.7	127.0	128.6	127.6	126.9	126.7	126.7	126.7
less												
CONSUMPTION[3]	68.7	69.6	88.1	96.4	103.5	107.2	112.0	109.0	110.1	112.5	114.2	113.5
equals												
NET INVENTORY INCREASE	29.8	35.6	27.8	23.2	20.2	19.8	16.6	18.6	16.9	14.2	12.5	13.2
plus												
BEGINNING INVENTORY	160.0	189.8	225.4	253.2	276.4	296.6	316.4	333.0	351.6	368.4	382.6	395.1
equals												
ENDING INVENTORY	189.8	225.4	253.2	276.4	296.6	316.4	333.0	351.6	368.4	382.6	395.1	408.3
RELATIVE INVENTORY[4] (yrs)	2.3	2.7	2.6	2.6	2.7	2.8	2.8	3.1	3.2	3.3	3.4	3.5

[1] World outside Communist areas.

[2] Ref. Nuexco Report 141, pg. 1.4.

[3] Natural uranium entering enrichment-fabrication pipeline for later use in a reactor. Ref. Nuexco Report 140, pg. 1.1.

[4] For each year, Relative Inventory equals Beginning Inventory divided by Consumption.

URANIUM MARKET

Table 2
NATURAL URANIUM SUPPLY-DEMAND BALANCE: US
(millions of pounds U_3O_8)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
PRODUCTION[1]												
Operating Production Centers	37.0	35.1	32.6	32.0	30.0	26.4	25.9	23.0	22.4	22.3	22.3	22.3
Facilities Under Construction	-0-	0.7	2.4	2.9	3.4	3.8	3.8	3.8	3.8	3.8	3.8	3.8
Firm Supply	37.0	35.8	35.0	34.9	33.4	30.2	29.7	26.8	26.2	26.1	26.1	26.1
less												
CONSUMPTION[2]												
Reactors Now Operational	16.3	17.6	17.7	17.4	17.9	18.2	18.4	17.8	18.3	18.4	18.3	17.8
Now Under Construction	8.5	10.9	19.7	22.5	24.6	23.6	23.1	25.3	25.5	25.5	25.2	25.2
Now On Order	-0-	-0-	-0-	-0-	2.0	2.4	4.8	4.4	4.3	5.6	7.8	7.3
Total	24.8	28.5	37.4	39.9	44.4	44.2	46.4	47.5	48.1	49.6	51.3	50.3
plus												
NET IMPORTS (EXPORTS)[3]	(1.8)	(1.9)	0.3	1.5	1.2	1.7	0.1	0.6	0.6	0.6	1.0	1.1
equals												
SUPPLY SURPLUS (DEFICIT)	10.4	5.4	(2.1)	(3.5)	(9.8)	(12.3)	(16.6)	(20.1)	(21.3)	(22.9)	(24.2)	(23.1)
plus												
BEGINNING INVENTORY	66.4[4]	76.8	82.2	80.1	76.6	66.8	54.5	37.9	17.8	-0-	-0-	-0-
equals												
ENDING INVENTORY	76.8	82.2	80.1	76.6	66.8	54.5	37.9	17.8	-0-	-0-	-0-	-0-
RELATIVE INVENTORY (yrs)[5]	2.7	2.7	2.2	2.0	1.7	1.5	1.2	0.8	0.4	-0-	-0-	-0-

[1] Ref. Nuexco Report 141, pg. 1.2.

[2] Ref. Nuexco Report 140, pg. 1.1.

[3] Ref. Table 3, below.

[4] George F. Combs, Jr.: "The US Uranium Market—1978-1979" USDOE; Grand Junction, Colorado; October, 1979.

[5] For each year, Relative Inventory equals Beginning Inventory divided by Consumption.

Table 3
US IMPORT-EXPORT BALANCE[1]
(millions of pounds U_3O_8)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
IMPORTS												
Annual	6.1	5.6	6.6	6.8	5.5	4.9	2.1	2.0	2.0	2.0	2.0	2.0
Cumulative	6.1	11.7	18.3	25.1	30.6	35.5	37.6	39.6	41.6	43.6	45.6	47.6
EXPORTS												
Annual	7.9	7.5	6.3	5.3	4.3	3.2	2.0	1.4	1.4	1.4	1.0	0.9
Cumulative	7.9	15.4	21.7	27.0	31.3	34.5	36.5	37.9	39.3	40.7	41.7	42.6
NET IMPORTS (EXPORTS)												
Annual	(1.8)	(1.9)	0.3	1.5	1.2	1.7	0.1	0.6	0.6	0.6	1.0	1.1
Cumulative	(1.8)	(3.7)	(3.4)	(1.9)	(0.7)	1.0	1.1	1.7	2.3	2.9	3.9	5.0

[1] Does not include contracts currently under litigation

URANIUM MARKET

Table 4

NATURAL URANIUM SUPPLY-DEMAND BALANCE: US

(Assumes US Buyers Maintain At Least 18 Months Forward Consumption in Inventory)
(millions of pounds U_3O_8)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
CONSUMPTION[1] × 1.5	37.2	42.8	56.1	59.9	66.6	66.3	69.6	71.3	72.2	74.4	77.0	75.5
less												
BEGINNING INVENTORY	66.4[2]	76.8	82.2	80.1	76.6	66.8	69.6	71.3	72.2	74.4	77.0	75.5
plus												
ANNUAL SUPPLY DEFICIT (SURPLUS)[3]	(10.4)	(5.4)	2.1	3.5	9.8	12.3	16.6	20.1	21.3	22.9	24.2	23.1
plus												
MINIMUM INVENTORY INCREASE[4]	-0-	-0-	-0-	-0-	-0-	3.3	1.7	0.9	2.2	2.6	(1.5)	1.0
equals												
UNFILLED US DEMAND[5]	-0-	-0-	-0-	-0-	-0-	15.1	18.3	21.0	23.5	25.5	22.7	24.1
ENDING INVENTORY[6]	76.8	82.2	80.1	76.6	66.8	69.6	71.3	72.2	74.4	77.0	75.5	76.5
RELATIVE INVENTORY (yrs)[7]	2.7	2.7	2.2	2.0	1.7	1.5	1.5	1.5	1.5	1.5	1.5	1.5

[1] 1.5 times apparent future consumption from Nuexco Report 140, pg. 1.1.

[2] George F. Combs, Jr.: "The US Uranium Market—1978-1979" USDOE; Grand Junction, Colorado; October, 1979.

[3] Ref. Table 2, above.

[4] Needed to make Ending Inventory (year N) equal 1.5 times Consumption (year N +1).

[5] Unfilled US demand is defined as that additional amount of uranium, if any, which US buyers would have to purchase over and above US firm supply in order to maintain a minimum relative inventory of 1.5 years forward consumption.

[6] Ending Inventory is derived as the greater of [Beginning Inventory less Annual Supply Deficit (Surplus)] and [1.5 times the following year's Consumption].

[7] For each year, Relative Inventory equals Beginning Inventory divided by Consumption.

Table 5

NATURAL URANIUM SUPPLY-DEMAND BALANCE: WOCA OUTSIDE US

(Assumes US Maintains Minimum Inventory of 18 Months Forward Consumption by Importing)

(millions of pounds U_3O_8)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
PRODUCTION[1]												
Operating Production Centers	61.5	69.1	76.5	78.3	80.1	82.1	82.1	83.0	82.9	82.8	82.8	82.8
Facilities Under Construction	-0-	0.3	4.4	6.4	10.2	14.7	16.8	17.8	17.8	17.8	17.8	17.8
Firm Supply	61.5	69.4	80.9	84.7	90.3	96.8	98.9	100.8	100.7	100.6	100.6	100.6
less												
CONSUMPTION[2]												
Reactors Now Operational	19.7	21.2	21.2	21.2	21.2	21.3	21.3	21.3	21.3	21.3	21.3	21.3
Now Under Construction	24.2	19.8	28.8	32.5	29.3	31.6	31.1	29.9	30.2	30.2	30.2	30.2
Now On Order	-0-	-0-	0.7	2.7	8.6	10.1	13.1	10.2	10.5	11.3	11.2	11.5
Total	43.9	41.0	50.7	56.4	59.1	63.0	65.5	61.4	62.0	62.8	62.7	63.0
plus												
NET IMPORTS (EXPORTS)[3]	1.8	1.9	(0.3	(1.5)	(1.2)	(1.7)	(0.1)	(0.6)	(0.6)	(0.6)	(1.0)	(1.1)
plus												
ADDITIONAL EXPORTS[4]	-0-	-0-	-0-	-0-	-0-	(15.1)	(18.3)	(21.0)	(23.5)	(25.5)	(22.7)	(24.1)
equals												
SUPPLY SURPLUS	19.4	30.3	29.9	26.8	30.0	17.0	15.0	17.8	14.6	11.7	14.2	12.4
plus												
BEGINNING INVENTORY	93.6[5]	113.0	143.3	173.2	200.0	230.0	247.0	262.0	279.8	294.4	306.1	320.3
equals												
ENDING INVENTORY	113.0	143.3	173.2	200.0	230.0	247.0	262.0	279.8	294.4	306.1	320.3	332.7
RELATIVE INVENTORY (yrs)[6]	2.1	2.8	2.8	3.1	3.4	3.7	3.8	4.3	4.5	4.7	4.9	5.1

[1] Ref. Nuexco Report 141, pg. 1.2.

[2] Apparent future consumption from Nuexco Report 140, pg. 1.1.

[3] Ref. Table 3, above. Non-US exports equal US imports and vice versa.

[4] Additional Exports to the US needed by the US to maintain a minimum inventory of 18 months forward consumption. Ref. Table 4, above, Unfilled Demand.

[5] Nuexco estimate.

[6] For each year, Relative Inventory equals Beginning Inventory divided by Consumption.

AUSTRALIA

As noted in Nuexco Report 140, the **British** Civil Uranium Procurement Organization (BCUPO) has elected not to participate in the equity financing of Energy Resources of Australia (ERA). Although the timetable for British uranium requirements has been extended, the basic reason underlying this decision is the same that has led to the extended and difficult negotiation with the prospective Japanese and German investors: without price concessions, there is little motivation to assume the risks of an equity investment. The argument that an equity position enhances long-term security of supply is less compelling in a period of weakening prices, declining demand and perceived oversupply. Nevertheless, progress in the formation of ERA continues, albeit more slowly than anticipated.

A key Australian government requirement for inclusion in Australian uranium supply contracts is agreement by buyers to accept, with five years prior notice with respect to conversion, and eight years prior notice with respect to enrichment, up to 35 percent of scheduled deliveries in the form of natural or enriched UF_6. This requirement relates to deliveries after 1990 to the extent that such services are available in Australia on competitive commercial terms. In view of the uncertainty surrounding the prospects for Australian conversion and enrichment, this requirement has been objectionable to buyers, especially those with long-term obligations for conversion and enrichment. Originally, the Australian announcement of intent to develop enrichment capability was met with a good deal of skepticism worldwide, particularly in view of the apparent glut of enrichment capacity. However, recent developments have increased the credibility of the Australian position. Specifically, USDOE has indicated interest in participating in a multi-national, Australian-based enrichment facility, and the Japanese have reiterated their interest in participating. Thus, buyers may well have to give greater consideration to this aspect of Australian supply.

Commissioning of Queensland Mines' Nabarlek mill is now well advanced and remains on schedule. First production of U_3O_8 is expected this month.

CANADA

Atomic Energy of Canada Ltd. (AECL) and the **Argentine** Comision Nacional de Energia Atomica (CNEA) have agreed to revise an earlier agreement associated with the Candu reactor under construction at Embalse, Cordoba. The revision revolves around the treatment of cost overruns at the Embalse site.

It also extends the period of technology exchange to cover the first years of operation of the reactor, and gives CNEA direct project management of the nuclear side of the project. The resolution of these problems will probably return AECL to a competitive position in regard to future reactor orders from CNEA, provided the two countries can resolve their differences on the nuclear safeguards issue.

Canada's stance on safeguards had tended to put AECL at a competitive disadvantage with other nations in doing business with Argentina. Last year AECL lost to competition from Kraftwerk Union (KWU) of the **Federal Republic of Germany** in its bid to sell a second heavy water reactor nuclear unit to Argentina.

EUROPE

The **Swedish** government has approved the loading of the country's ninth and tenth nuclear units, Forsmark unit 2 (900 MWe BWR) and Ringhals unit 4 (915 MWe PWR). Fuel loading at Forsmark unit 2 will take place in the fall of 1980. It is scheduled to begin commercial operation in 1981. Ringhals unit 4 will be loaded in 1981 and is expected to be commercial by mid-1982. The validity of the licenses is through 1986, at which time evidence must be provided that reprocessing and waste disposal are available, as required by Swedish law.

A recent public opinion poll in **Austria** showed 36 percent of the electorate in favor of nuclear power, 30 percent against. This is a small shift in favor of nuclear power. Sufficient signatures have been collected to start an initiative to rescind the law prohibiting nuclear power generation in Austria, and it is hoped that the move will be put to a vote early in 1981. Parliament would, however, have to sanction such a rescindment. A study undertaken to evaluate the conversion of the 700 MWe Tullnerfeld plant near Zwentendorf to a coal or oil-fired plant proved negative. The utility, GKT, will attempt to preserve the unit in its present state at least through 1984.

The state utility of **Italy**, Ente Nazionale per l'Energia Elettrica (ENEL) has received government sanction for its program for 1980-90. During this period. ENEL plans to add 27,030 MWe of capacity, more than one third of which will be provided by ten 1,000 MWe nuclear units at five different plant sites.

In **Switzerland**, anti-nuclear groups in three cantons have officially launched another initiative to halt all nuclear plants having a start-up date later than January 1, 1985. The main targets of the initiative are the Kaiseraugst and Graben plants. The groups now have 18 months in which to collect the signatures required to put the initiative to a vote.

The Central Electricity Generating Board (CEGB) of the **UK** has issued a letter of intent to the British National Nuclear Corporation for the 1,100 MWe PWR at Sizewell in Essex. The UK plans to increase nuclear generating capacity by 15,000 MWe through 1990.

Some within the **Federal Republic of Germany** continue to express concern that German industry will become uncompetitive with **French** industry because of the latter's heavy reliance on cost-effective nuclear power. They point out that a nuclear unit in France would be expected to cost only 70% of what a comparable unit would cost in Germany, and that gap can be expected to widen as the French forge ahead with their accelerated nuclear power program. The cost differential arises from the longer construction time in the FRG due to licensing logjams, as well as the benefits derived from standardization by the French of their nuclear hardware and licensing procedures.

In 1980, a new political party in the FRG known as the "Greens" has developed. The Greens are an environmentalist, strongly anti-nuclear party intent on shutting down operating nuclear plants and preventing new ones from coming on line. The Greens have surprised many by managing to capture enough of the popular vote to place candidates in some of the state legislatures.

Despite these problems, the FRG brought three new nuclear units with a combined generating capacity of about 3,100 MWe on line in 1979.

Last month, the German firm Kraftwerk Union (KWU) signed a contract with the **Argentine** CNEA for a 745 MWe natural uranium heavy water reactor at the Atucha site. The first Atucha unit was supplied by KWU/Siemens.

FAR EAST

The **People's Republic of China** (PRC) has apparently rekindled its interest in nuclear power. It is proceeding with plans to build two 900 MWe nuclear units near Canton. China Power and Light of Hong Kong has agreed to purchase 40 percent of the power, and will finance 40 percent of the plant on the basis of equivalent plant cost elsewhere, i.e. outside the PRC.

The leading contenders to supply the nuclear units are Framatome (**France**), National Nuclear Corporation (**UK**) and Westinghouse (**US**). Framatome is apparently attempting to have the two plants which had previously been negotiated for the Shanghai area (but later cancelled) reinstated as orders for the Canton site. The French are offering a good financing package, and are not requiring safeguards. These are seen as advantages for Framatome. The US State Department has indicated that since the PRC is a nuclear weapons state under the Non-proliferation Treaty, full-scope safeguards would not be required under the bilateral agreement for cooperation which the US State Department hopes to negotiate with the PRC this year. That is, only the material and technology transferred would be subject to safeguards. The latter would be an advantage to Westinghouse; however, there is no assurance that US Export-Import Bank financing would be available, which might be a disadvantage. Britain's National Nuclear Corporation is offering a PWR based on the Westinghouse license. The presence of Hong Kong financing must be regarded as an advantage for the British.

In addition to the two units for Canton, two units in the Shanghai area, and two more in the northern part of the country are in planning.

UNITED STATES

The US Department of Energy (USDOE) has published its latest estimate of US uranium reserves. The estimate indicates that US reserves producible at a forward cost of $50 per pound U_3O_8 or less increased slightly to 936,000 tons U_3O_8 as of January 1, 1980, from 920,000 tons the year before. About 93,000 tons were added to reserves in this cost category in 1979; however, 57,000 tons were removed because of cost increases and revaluation, and 20,000 tons of reserves were mined to yield approximately 37 million pounds U_3O_8 (after mill losses) produced in the US last year.

URANIUM MARKET

The average grade of ore mined in the US last year was 0.11 percent U_3O_8. Nuexco estimates that the average grade of ore mined in the US during 1980 will fall below 0.10 percent U_3O_8. For comparison, according to USDOE, the average grade of all US reserves recoverable at a forward cost of $50 or less ranges from 0.09 percent in New Mexico to 0.05 percent in Texas.

The term *forward cost*, as used by USDOE, includes only forward capital and operating costs. It does not include recovery of sunk costs, interest, return on investment or income taxes. Thus, the price necessary to exploit reserves economically would be considerably higher than the forward cost. The concept of forward cost was discussed in detail in Nuexco Report 138.

The US Nuclear Regulatory Commission (NRC) unanimously voted to refuse an export license for enriched uranium intended for India's Tarapur plant. The reason given for the NRC refusal was that India is not a party to the Non-proliferation Treaty, and therefore the NRC Commissioners felt that exporting to India would not meet the criteria of the 1978 US Nuclear Non-Proliferation Act (NNPA). President Carter has the authority under the NNPA to overturn the NRC finding. However, Congress, in turn, has 60 legislative days in which to override the President's action by concurrent resolution (i.e. both the House and the Senate must vote to override the President's decision). It is likely that the Tarapur issue will ultimately be decided by Congress.

Three nuclear units have been licensed for low power testing by the NRC this year. They are Sequoyah unit 1 (Tennessee Valley Authority), North Anna unit 2 (Virginia Electric and Power Co.) and Salem unit 2 (Public Service Electric & Gas Co.). Additional approvals must be obtained for power generation. The next unit to receive such a low power license is likely to be La Salle unit 1 (Commonwealth Edison Co.). Other units which may soon follow include Zimmer (Cincinnati Gas & Electric Co.), McGuire unit 1 (Duke Power Co.), Summer (South Carolina Electric & Gas Co.), Watts Barr unit 1 (TVA), Shoreham (Long Island Lighting Co.) and Diablo Canyon units 1 and 2 (Pacific Gas & Electric Co.).

TRANSACTIONS

Four transactions are reported this month, of which only one is for near-term delivery. Two of the transactions, each under 600,000 pounds, involve US producers selling to buyers located in France and the Federal Republic of Germany; one of these is a production output contract (i.e. buyer obligated to take seller's production, if seller produces). In both cases the price is fixed, and one involves payments in advance of delivery. The German buyer is a utility; the French buyer is a producer.

The other two transactions involve Canadian producers as sellers. The smaller of the two transactions, under 300,000 pounds, is for immediate delivery at a fixed price near current Exchange Value. The buyer is a European utility. The larger transaction has a price related to the market price at the time of delivery, with a floor price, escalated. This deal involves over four million pounds. The buyer is a Far East utility.

PRICING

The **Exchange Value** remained unchanged this month at $32.00 per pound U_3O_8. Downward pressure on the market was relieved somewhat by the return of lower interest rates and more plentiful loan money. Therefore, some of the US utility sellers have reduced their efforts to sell.

Inquiries to sell material for 1980 delivery involve a total of 4.2 million pounds U_3O_8. However, the sellers of a substantial portion of that material have not been willing to consider a sale at a price as low as current Exchange Value. Some sellers, however, have been willing to reduce offer prices, and a few potential transactions are under discussion as a result. Inquiries to purchase for 1980 delivery involve a total of 1.2 million pounds U_3O_8. The potential buyers include uranium producers, but it is significant that utility buyers have returned to the market. Near-term inquiries have surfaced in Europe, as have spot, intermediate and long-term inquiries in the United States. It appears that at least some utility buyers believe the market is nearing, or has achieved, a bottom, and are hoping to acquire material at what they view as attractive prices. Decisions to enter the market after a short period of rapid price decline also suggest that some buyers believe the bottom may be of short duration.

with the possibility that the sharp price decline could be followed quickly by an equally vigorous rebound. The extent and speed of any rebound will depend largely on how aggressively the current inquiries are pursued by the prospective buyers.

Another indication that prices may be bottoming involves the participation in the market of producer-buyers. To the extent that near-term market price falls, producer interest in buying, rather than making, should increase accordingly. Figure 1 indicates Nuexco's estimate of the distribution of current US uranium production costs. The horizontal axis represents full production costs (i.e. variable and fixed costs), excluding return on investment. The vertical axis represents the percentage of US producers whose average production cost is higher than the cost indicated at any point on the curve (i.e. Figure 1 is an integral cost distribution).

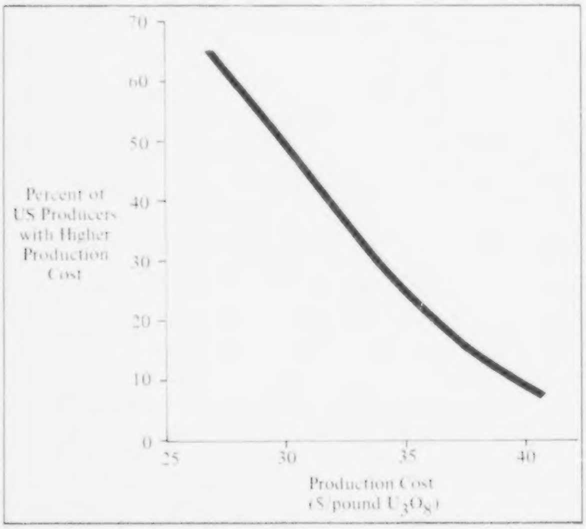

Figure 1
ESTIMATED DISTRIBUTION OF US URANIUM PRODUCTION COST

Figure 1 might suggest that at the current Exchange Value of $32.00 per pound U_3O_8, there would be substantial interest among US producers in buying, rather than producing, to make deliveries under existing contracts. However, Figure 1 probably overstates potential producer interest in buying. The producer's cash flow may continue to be favorable for production, even if cost accounting would indicate that purchasing is economically more beneficial. This is because there are usually certain fixed costs which have to be met, regardless of the output level of a production center. Also, some mines cannot be shut down without irreparable damage.

However, Figure 1 does indicate how purchasing activity by producers can serve to underpin the market. As prices decrease, more producers find it more attractive to buy, rather than to produce, thus putting upward pressure on the market, even if utility buyers are inactive. The uranium market appears to be at or near the level at which there might be sufficient producer interest to forestall the continued rapid collapse in prices experienced over the past few months.

The **Transaction Value** decreased somewhat this month to $37.90 per pound U_3O_8. The Transaction Value is still largely influenced by transactions which closed as long as four months ago, when prices were much higher. The Transaction Value sample must have a minimum of ten transactions totaling at least two million pounds, and must include transactions closing over a minimum of three months (see Statistical Data section of this Report for complete definition). This built-in inertia in determining Transaction Value will always cause it to lag changes in the Exchange Value.

TOPICAL ESSAY

SOME PERSPECTIVES ON URANIUM INVENTORY

Introduction

Uranium inventory is becoming an increasingly important presence in the market. The near-term market has been greatly affected by the inventory policies of US utilites over the past several months. Relatively large amounts of material have been offered for sale by US inventory holders, thus contributing to downward pressure on near-term market prices.

The purpose of this essay is to:

- analyze the current inventory status
- review the factors which led to the current inventory position
- discuss the trends developing in inventory practices
- consider the implications for the uranium market.

This essay focuses on inventories in the US, since US inventory practices seem to be having the greatest effect on the near-term market. The conclusions, however, apply generally to the world market.

Current US Inventory Status

For purposes of this essay, inventory is defined as uranium owned by users, in the form of natural concentrates or natural UF_6. A related definition is that changes in the aggregate industry inventory level result from the difference between production and consumption of uranium, where consumption is defined as natural uranium which enters the enrichment-fabrication pipeline for later use in a reactor. While this statement seems obvious, it highlights the fact that inventory is the surge tank between production and consumption of uranium. If producers do not hold significant inventory (US producers do not hold significant inventories; some non-US producers have been observed to hold inventories at times) then it is only the willingness of users to accumulate inventories which enables uranium production to exceed consumption. Worldwide uranium production has, in fact, exceeded consumption in every year of the civilian nuclear power program.

Nuexco's estimates of the recent US inventory situation is outlined quantitatively in Tables 2 and 4, above. At the beginning of calendar year 1980, US uranium inventory was 76.8 million pounds U_3O_8 equivalent by Nuexco's assessment. At the end of 1980, US inventory is expected to be about 82.2 million pounds U_3O_8 equivalent. For the most part, this material is physically located at the facilities of USDOE, or the two US conversion contractors, although relatively small amounts may be stored with non-US converters. In addition to the converters and USDOE, at least two commercial storage facilities are now licensed in the US. However, significant amounts of US-owned inventory has not yet been moved into these facilities.

Table 6 contains Nuexco's estimate of the distribution of US-owned commercial inventories by location, expressed as a percent of total US inventory (currently about 80 million pounds of U_3O_8 equivalent). Table 6 also contains Nuexco's estimate of the chemical form (either U_3O_8—i.e. concentrates—or UF_6) in which the inventory currently exists.

Table 6

ESTIMATED DISTRIBUTION OF US-OWNED COMMERCIAL INVENTORY, BY LOCATION
(percent of total)

Location	as U_3O_8	as UF_6	Location Total
Allied Chemical	22	10	32
Kerr-McGee	21	19	40
USDOE	0	28	28
TOTALS	43	57	100

The US-owned commercial inventory level of about 80 million pounds U_3O_8 equivalent does not include uranium "inventory" owned by USDOE. Nuexco estimates that USDOE now owns approximately 45 million pounds U_3O_8 equivalent, in the form of natural UF_6. In addition, Nuexco estimates that USDOE owns a stockpile of enriched UF_6 containing a feed content of 111 million pounds U_3O_8 equivalent. Thus the total US national stockpile of uranium, outside of fabricated fuel, is about 236 million pounds U_3O_8 equivalent, including both commercial and government-owned inventories. It is interesting to note that the latter figure is about ten times actual US consumption of natural uranium in 1979 (see Table 2, above). Thus the US will clearly not be vulnerable to embargoes from uranium exporting countries for the foreseeable future.

Aside from the US government stockpile, the US commercial inventory level at the end of 1980 is expected to be about 2.7 years forward consumption, or about a 1,000 day forward supply. For comparison, US government studies typically assume an average oil inventory among US utilities of not more than 30 days. Currently, coal inventories among US utilities average about 120 days forward supply. While there is a substantial difference among oil, coal and uranium from the standpoint of inventory measured in days of forward supply, there is very little difference when they are measured in terms of inventory *value*. Table 7 was prepared to demonstrate this. The left-hand column of figures in Table 7 contains the average inventory levels discussed above, for oil, coal and uranium. The middle column represents fuel costs in US dollars per million Btu's of energy content for each fuel. The oil cost of about $6.00/MBtu's is based on current OPEC prices. A typical US coal price is difficult to quantify because of the large variance about the mean, but a delivered price of $1.40/MBtu appears about average in many parts of the country. The natural uranium cost of about $0.18/MBtu is based on the current Exchange Value of $32 per pound U_3O_8. (For reference, $0.18/MBtu includes only the cost of natural uranium. It does not include enrichment or fabrication.) The right-hand column of Table 7 is the product of the first two columns and represents the *relative value* of the fuel inventory, expressed in arbitrary units. As indicated, the average dollar values of US utility inventories of oil, coal and uranium are roughly the same.

Table 7

RELATIVE VALUES OF AVERAGE US UTILITY INVENTORIES OF OIL, COAL AND URANIUM

Fuel	Average Inventory (days forward supply)		Average Fuel Cost ($/MBtu)		Average Inventory Value (arbitrary units)
Oil	30	x	6.00	=	180
Coal	120	x	1.40	=	168
Uranium	1000	x	0.18	=	180

The distribution of relative inventory levels among US utilities is shown in Table 8. The wide distribution indicates there is not really a *normal* inventory position in the US. The clustering in Table 2 below two years inventory suggests a majority of US utilities desires to maintain less than two years inventory. This is consistent with discussions Nuexco has had with uranium users. US utilities holding more than two years forward consumption in inventory usually are doing so because of nuclear plant delays, combined with pre-existing long-term uranium contracts.

Table 8

DISTRIBUTION OF RELATIVE INVENTORY LEVELS FOR US UTILITIES[1]

Years of Forward Consumption in Inventory as of End of 1980	Number of Utilities
0-1	18
1-2	14
2-3	9
3-4	4
4-5	2
5-6	0
greater than 6	9

[1] US median is estimated at 1.5 years as of end of 1980.

Factors Which Led to the Current US Inventory Position

One important factor in the current US position is that much of the inventory was acquired involuntarily. Contracting for U_3O_8 in the late 1960's and early 1970's was based on the then-optimistic outlook for nuclear power growth. Subsequently, delays in licensing and construction reduced consumption, but inventory buildup continued under long-term contracts. Although this buildup was unplanned, another important factor leading to the current high inventory position is that inventories were in fact largely retained rather than avoided by deferrals of deliveries, or by resale of the material. Holding large amounts of inventory became an acceptable practice for several reasons, one of which was assurance of supply, a primary concern because:

- It was difficult to make long-term contracts during the period of rapidly rising price in 1974 and 1975, causing uranium buyers concern about later availability.
- The unprecedented litigation which overtook the uranium industry beginning in 1975 added further uncertainty about supply.
- Finally, there was political uncertainty resulting from events such as Canada's suspension of exports for 12 months while safeguards requirements were in dispute, and the domestic contro-

versy which paralyzed Australia's market entry as a supplier in the 1970's.

Another important factor which allowed large inventories to be carried was the relatively low carrying cost. Although spot market prices exceeded $40 per pound in the late 1970's, the bulk of uranium was delivered under long-term contracts, often at prices considerably below the then-prevailing spot price. Until recently, interest rates were not troublesome to utilities or their regulatory commissions, and the utilities were usually permitted to recover the entire cost of carrying uranium inventories. Thus utilities were not under a great deal of pressure to reduce inventories.

There were also a few less important factors contributing to inventory buildup. Buyers holding long-term contracts with low prices preferred to take delivery under those contracts even if the delivery schedule gave them material far too early, as the result of reactor delays. Buyers often did not negotiate extended delivery schedules, because sellers usually requested to renegotiate prices in exchange. Also, large amounts of uranium were accepted and stored in inventory because it is physically possible to do so conveniently. Unlike oil, coal and gas, uranium requires very little space for storage per unit of contained energy, and is stable indefinitely.

Current Trends in Inventory Management

In the US, there is a definite trend toward carrying lower levels of inventory. This results, in part, from initiative taken by the utilities themselves. In the utility industry, there is increasing emphasis on resource management and, as a result, holding large amounts of inventory is coming under scrutiny. In some cases, audits by management consultants have recommended carrying less inventory.

In addition to a growing disposition to hold less inventory, there is an increasing variety of methods available to manage inventory, and reduce its financial burden. Table 9 lists the sources and uses of uranium inventory. Although most are obvious, some deserve special mention:

- *Loans:* Typically, there are few uranium loan transactions, compared with the number of sales transactions. Assurance of payback is an important consideration. Now that future uranium supply is perceived to be more certain, this consideration is less troublesome, contributing to a greater availability of material available for loan. This should make the industry-wide inventory more fungible, and reduce the driving force *for the individual utility* to increase inventories.
- *Financial Markets:* Sale with a repurchase option or sale with a leaseback are both financing mechanisms for removing inventory from the utility's balance sheet and changing the manner in which uranium is financed. Usually, the inventory remains in storage somewhere and is still therefore an idle asset, but is recorded on a different set of books. Such transactions can improve the utilities' financial position and are being used increasingly in inventory management.

Table 9

FACTORS WHICH CHANGE INVENTORY LEVEL OF INDIVIDUAL HOLDERS

A. **Inventory Sources**
    1. Existing supply contracts
    2. Uranium Market
        a. Spot purchases
        b. Loans
    3. US Government sales or loans from stockpile

B. **Inventory Uses**
    1. Contractual demand for U_3O_8
        a. Conversion schedule
        b. Enrichment schedule
        c. Fabrication schedule
    2. Reactor demand
    3. Disposition via the uranium market
        a. Sale
        b. Loan
    4. Temporary Disposition via the financial market
        a. Sale with repurchase option
        b. Sale with leaseback obligation

EAST RAND GOLD & URANIUM COMPANY LIMITED (ERGO)

Introduction

Anglo-American Corporation of South Africa Limited (AAC) controls 12 mining operations located in the Witwatersrand basin of South Africa. Uranium is recovered in ten of the twelve operations, one of which is the East Rand Gold & Uranium Company Limited (Ergo).*

Ergo recovers gold and uranium from the previously untreated tailings of gold mining and milling operations. Originally, the mined ore was processed for gold only. However, recent refinements in extractive metallurgy make it economically feasible to recover both gold and uranium from the old tailings.

AAC originally re-treated slimes dams in the early 1950's to recover pyrite needed in the production of sulfuric acid, which was used in the by-product recovery of uranium from operating gold mines. These re-treatment operations ceased when demand for uranium declined in the mid-1960's. AAC resumed evaluating slimes dams for gold and uranium in 1973. At that time, geological and metallurgical investigations proved it to be economically feasible to process the slimes to recover those minerals from pyrite. Pyrite is essential to the recovery of the other minerals, since gold and uranium occur in the pyrite concentrate recovered during the flotation process.

Recovering gold and uranium from slimes dams is not a new concept. Throughout the past century, slimes dams have been accumulating in the gold mining districts. Almost without exception, the slimes which accumulated during the first 75 years of mining contain minor quantities of gold and uranium not recovered during the milling process.

Project Development

The Ergo facility uses slimes dams as its sole source of material to be treated for the recovery of valuable minerals. It does not engage in conventional mining and processing of ore. AAC's program in 1974-75 included testing recovery techniques in a pilot flotation plant specially designed to produce a three percent mineral concentrate from incoming slimes. Final feasibility studies indicated that, in order for the program to be viable, at least one million metric tons of slimes per month would have to be re-treated.

Transporting such large volumes of slimes presented new engineering problems. After detailed studies of rail, truck and pipeline transportation, it was concluded that the most economical method is to pump the slimes in slurry form to a central processing plant. Testing at the Vaal Reefs mine showed that the slimes could be broken down quickly and put into slurry form by using high-pressure water jets. The slurry could then be pumped to the processing plant.

During the later stages of the pilot program, AAC began to acquire the mineral rights to specific slimes dams. At least 19 slimes dams were acquired in the East Rand mining district. The dams contain about 400 million metric tons of material, which will be processed over the next 20 years. Figure 2 shows the location of the slimes dams in relation to the main processing plant operated by Ergo.

The decision to proceed with the project was made in January 1976. The initial plan was to pump slurry concurrently from three slimes dams to a central treatment complex. The complex would consist of a flotation plant, a uranium plant, three pyrite roasters, two acid plants and a gold plant. The pyrite concentrate would be treated to recover uranium, then roasted to produce sulfuric acid. Gold would be recovered from the residue resulting from the roasting process. Figure 3 is the basic flow diagram for the Ergo recovery process.

Uranium was first produced at the Ergo facility on February 25, 1978—about two years after construction began. Total expenditures during the construction period were 140 million South African Rand. Sulfuric acid production began on March 14, 1978, and the first gold bar was poured on April 11, 1978. Despite start-up problems, plant production reached an economically acceptable level within 90 days. Technical and mechanical problems persisted, however, and it was about nine months before full-capacity uranium production was achieved. It was a full year before gold and sulfuric acid production reached projected levels.

The Recovery Process

As the first step in development of the project, the slimes dams were sampled for mineral content by auger drilling on 330 and 660 foot centers. The drill

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*Gold is the primary mineral produced at Ergo, not uranium, as reported in Nuexco Report 141, May 1980.

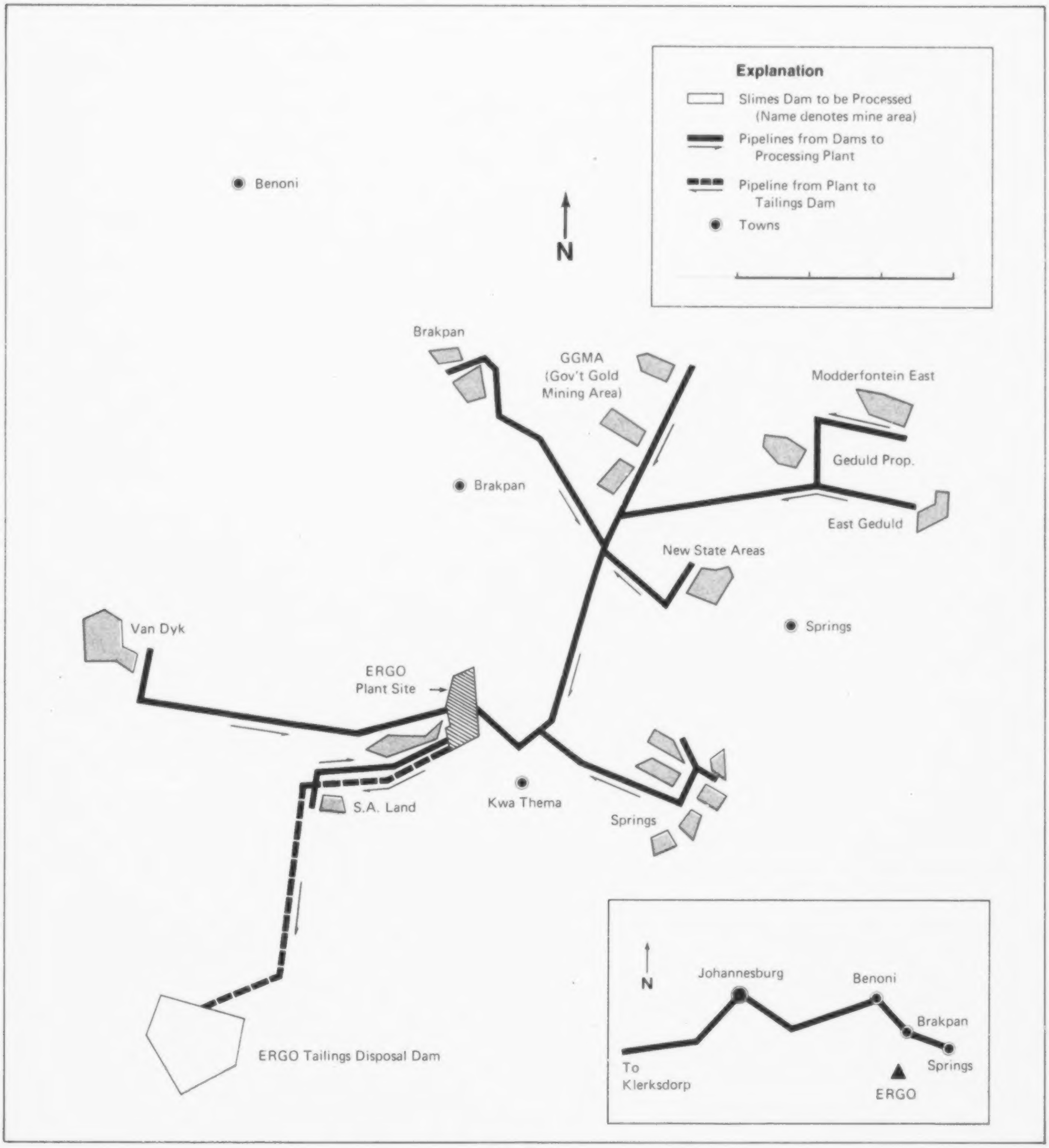

Explanation
Slimes Dam to be Processed (Name denotes mine area)
Pipelines from Dams to Processing Plant
Pipeline from Plant to Tailings Dam
Towns
N
Benoni
Brakpan
GGMA (Gov't Gold Mining Area)
Modderfontein East
Geduld Prop.
Brakpan
East Geduld
New State Areas
Springs
Van Dyk
ERGO Plant Site
S.A. Land
Kwa Thema
Springs
ERGO Tailings Disposal Dam
N
Johannesburg
Benoni
Brakpan
Springs
To Klerksdorp
ERGO

Figure 2
LOCATION MAP OF ERGO PROJECT AREA

samples were divided, with half assayed for gold and half delivered for analysis and metallurgical testing. During the sampling program, 980 holes, totalling about 74,000 feet, were drilled. Approximately one billion metric tons of slimes were evaluated during the test period.

The plan for moving the slimes involves specially-designed, hydraulically-operated water cannons. Water is pumped under high pressure directly into the slimes dam, the face of which is then washed away by the jet of water. A battery of three cannons is utilized on each dam to allow an even advance. Three dams at a time are subjected to water streams, in order to provide the flotation plant with approximately 1.8 million metric tons of material per month.

The slimes wash away from the working face as a slurry, which gravitates to a primary pumping station adjacent to each dam. The slurry from each dam is screened at the site, and pumped in separate pipelines to the flotation plant.

Slurries from the three slimes dams remain separate at the flotation plant, to accommodate any difference in metallurgical characteristics which may exist among the dams. All of the slurry is further prepared for froth flotation by dilution, followed by the addition of sulfuric acid and various chemical reagents. The prepared solution passes through a series of flotation cells, where the valuable mineral concentrate is separated, or floated, out. The tailings are then passed through three huge thickeners, each 454 feet in

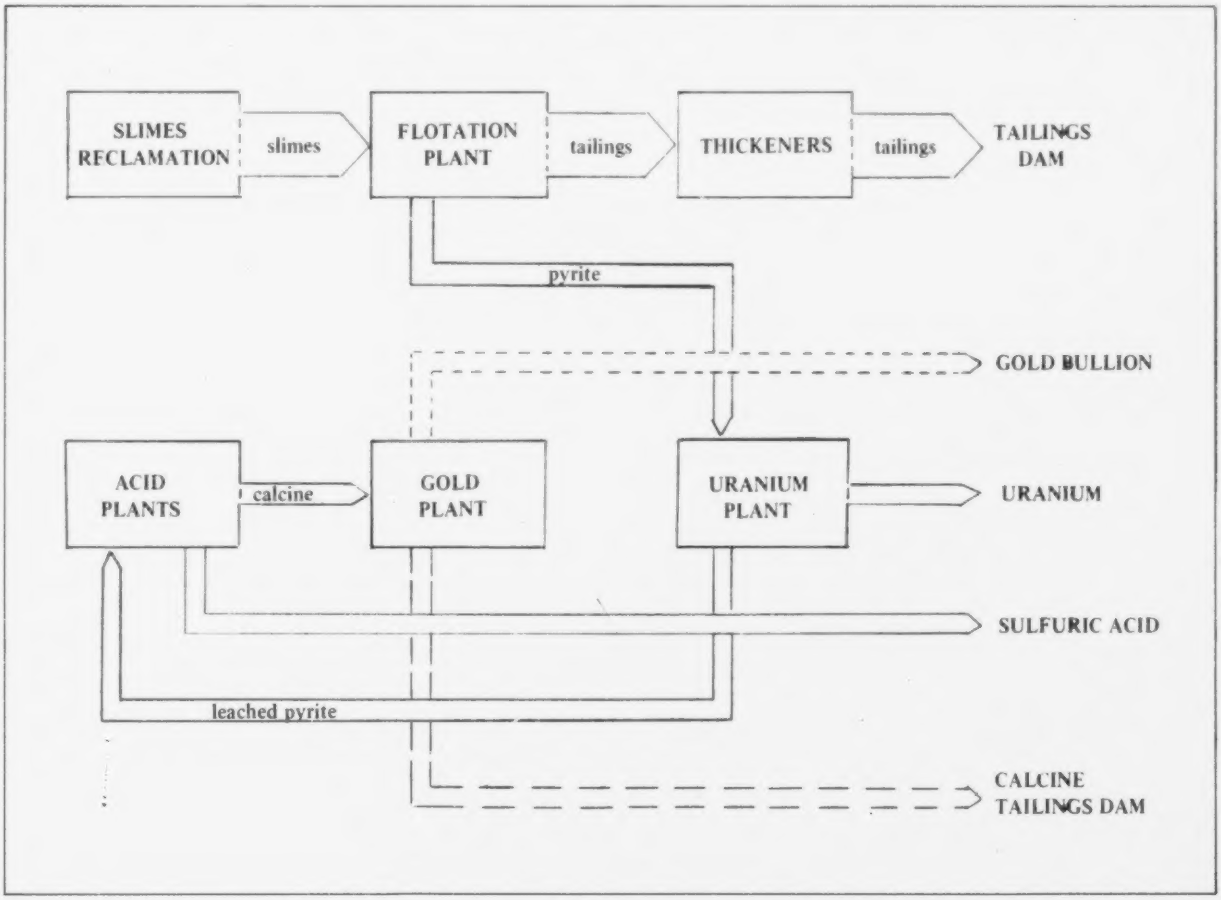

SLIMES RECLAMATION
slimes
FLOTATION PLANT
tailings
THICKENERS
tailings
TAILINGS DAM
pyrite
GOLD BULLION
ACID PLANTS
calcine
GOLD PLANT
URANIUM PLANT
URANIUM
SULFURIC ACID
leached pyrite
CALCINE TAILINGS DAM

Figure 3
ERGO RECOVERY PROCESS FLOW DIAGRAM

diameter, where plant water is recovered. The tailings are then piped to a new and specially-prepared tailings dam area about seven miles from the plant site.

The concentrate from the flotation plant is pumped to the uranium plant, where it is heated by steam. Then follows the addition of sulfuric acid, as required, to dissove the uranium oxide. The leached pulp is directed through a battery of rotary filters which separate the uranium-bearing solution from the pyrite. The solution is further processed by the counter-current liquid ion exchange method, whereby uranium is extracted as ammonium diuranate (ADU). The ADU is trucked in slurry form to the Nuclear Fuels Corporation of South Africa (Pty) Ltd. (NUFCOR) plant for calcining and packaging.

After the uranium has been leached out, the pyrite concentrate is pumped to the two sulfuric acid plants, which have a combined capacity of 1,500 metric tons per day. The concentrate is then passed into fluid-bed roasters, where sulfur dioxide and a residue referred to as calcine are formed. The sulfur dioxide gas is cleaned and, eventually, converted to sulfuric acid, a portion of which is reused in the uranium plant. The calcine, which contains the gold, is quenched with water for pumping to a thickener. After thickening, it is sent as a pulp to the gold plant, where it is polished in a ball mill to expose the surfaces of the gold particles. The pulp then enters a standard cyanidation circuit for extracting gold from slimes. The gold is precipitated by the addition of zinc and lead nitrate. The zinc is removed before the gold is smelted in an electric arc furnace and cast into bars. Figure 4 is a layout of the plant complex; Figure 5 is an aerial photograph of the central plant area.

Production Level

Production capability is building up to a monthly level of more than 32,000 pounds of U_3O_8, 500 kilograms of gold and 40,000 metric tons of sulfuric acid. These are recovered from raw material which has an average "grade" of 0.09 pounds U_3O_8 and 0.53 grams of gold per metric ton, and 1.04 percent sulfur. The average recovery factor is 20 percent for uranium, 55 percent for gold and 86 percent for sulfur. Research continues in order to improve the recovery percentage for each mineral, with emphasis on uranium.

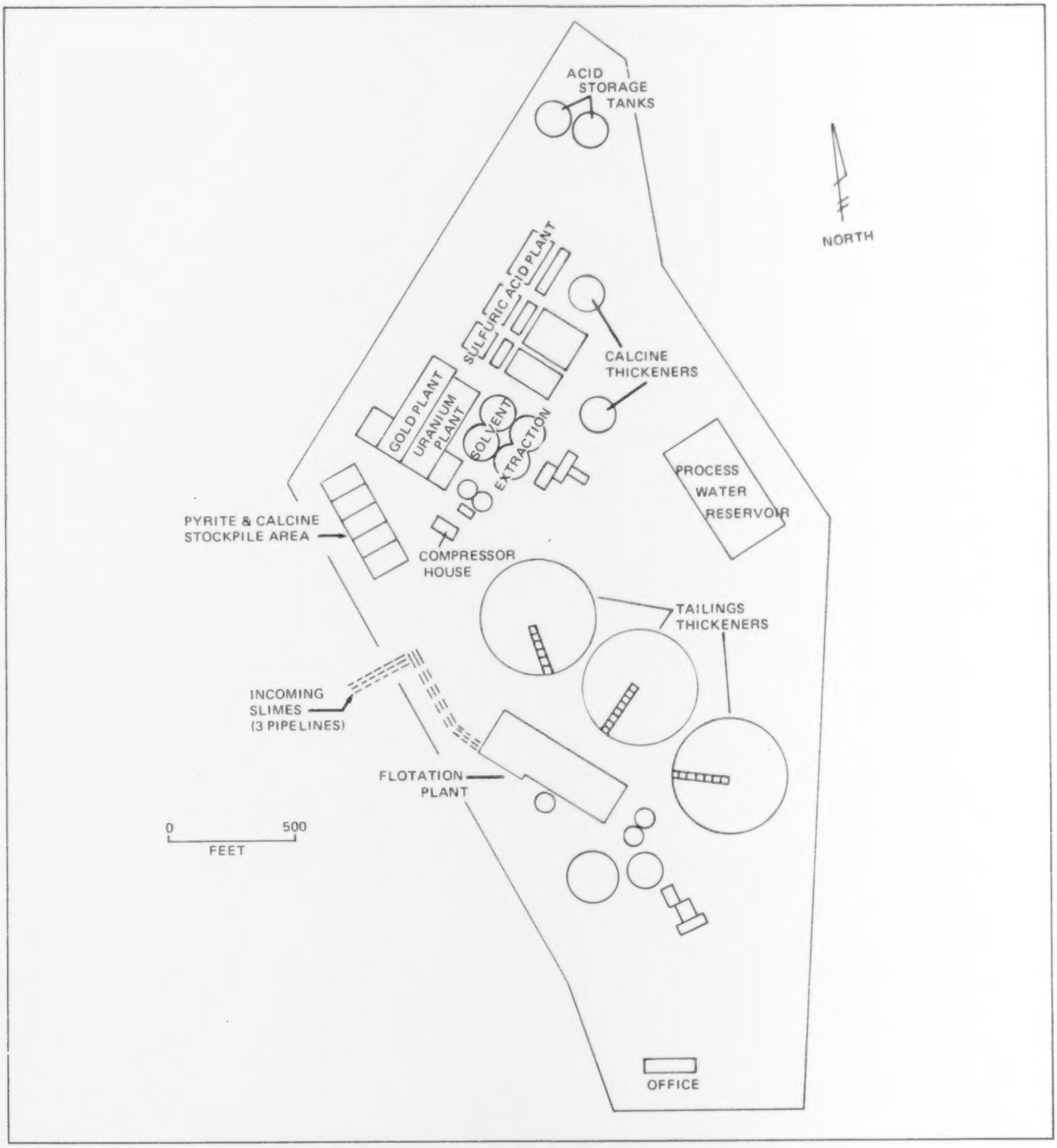

ACID STORAGE TANKS
NORTH
SULFURIC ACID PLANT
CALCINE THICKENERS
GOLD PLANT
URANIUM PLANT
SOLVENT
EXTRACTION
PROCESS WATER RESERVOIR
PYRITE & CALCINE STOCKPILE AREA
COMPRESSOR HOUSE
TAILINGS THICKENERS
INCOMING SLIMES (3 PIPELINES)
FLOTATION PLANT
0
500
FEET
OFFICE

Figure 4
LAYOUT OF ERGO PLANT COMPLEX

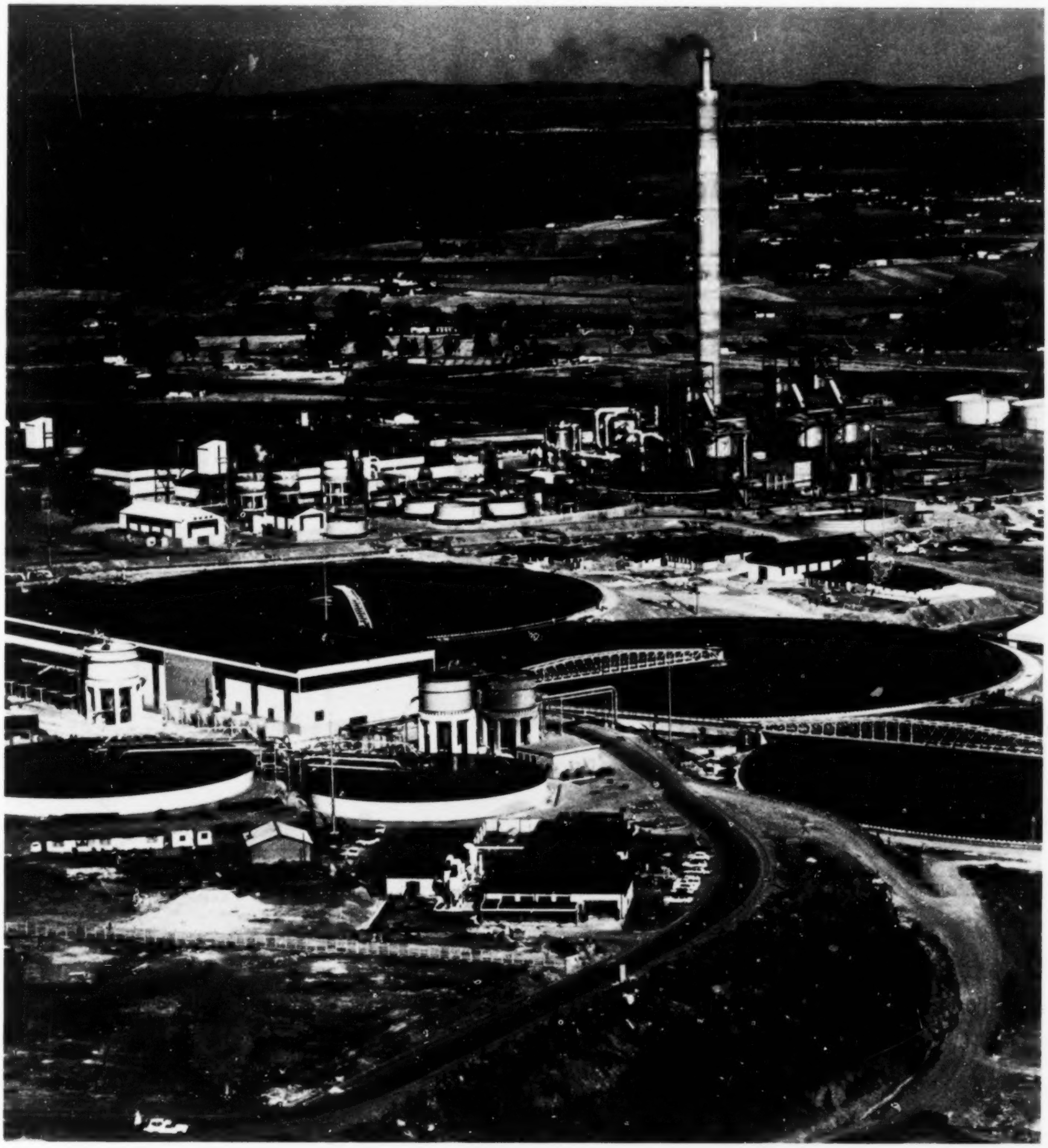


Figure 5
AERIAL VIEW OF ERGO'S CENTRAL PROCESSING PLANT

STATISTICAL DATA

EXCHANGE VALUE—$32.00/lb U_3O_8
Determined as of May 31, 1980

Definition

The Exchange Value is Nuexco's judgment of the price at which transactions for significant quantities of natural uranium concentrates could be concluded as of the last day of the month.

Derivation

Nuexco bases the Exchange Value upon:

A. Data from recently completed transactions.
B. Data from pending transactions.
C. Firm bids to buy and firm offers to sell.
D. Prices purchasers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy, and prices sellers have expressed a willingness to accept, but for which Nuexco is not aware of firm offers to sell.

Comments

Nuexco does not consider the following in determining the Exchange Value:

A. The price of uranium delivered or to be delivered under old contracts.
B. The price of uranium delivered in connection with contract renegotiations or other than arm's length transactions.

TRANSACTION VALUE
Determined as of May 31, 1980

$/lb U_3O_8	Millions of Pounds	Number of Transactions	Number of Months
37.90	3.9	14	4

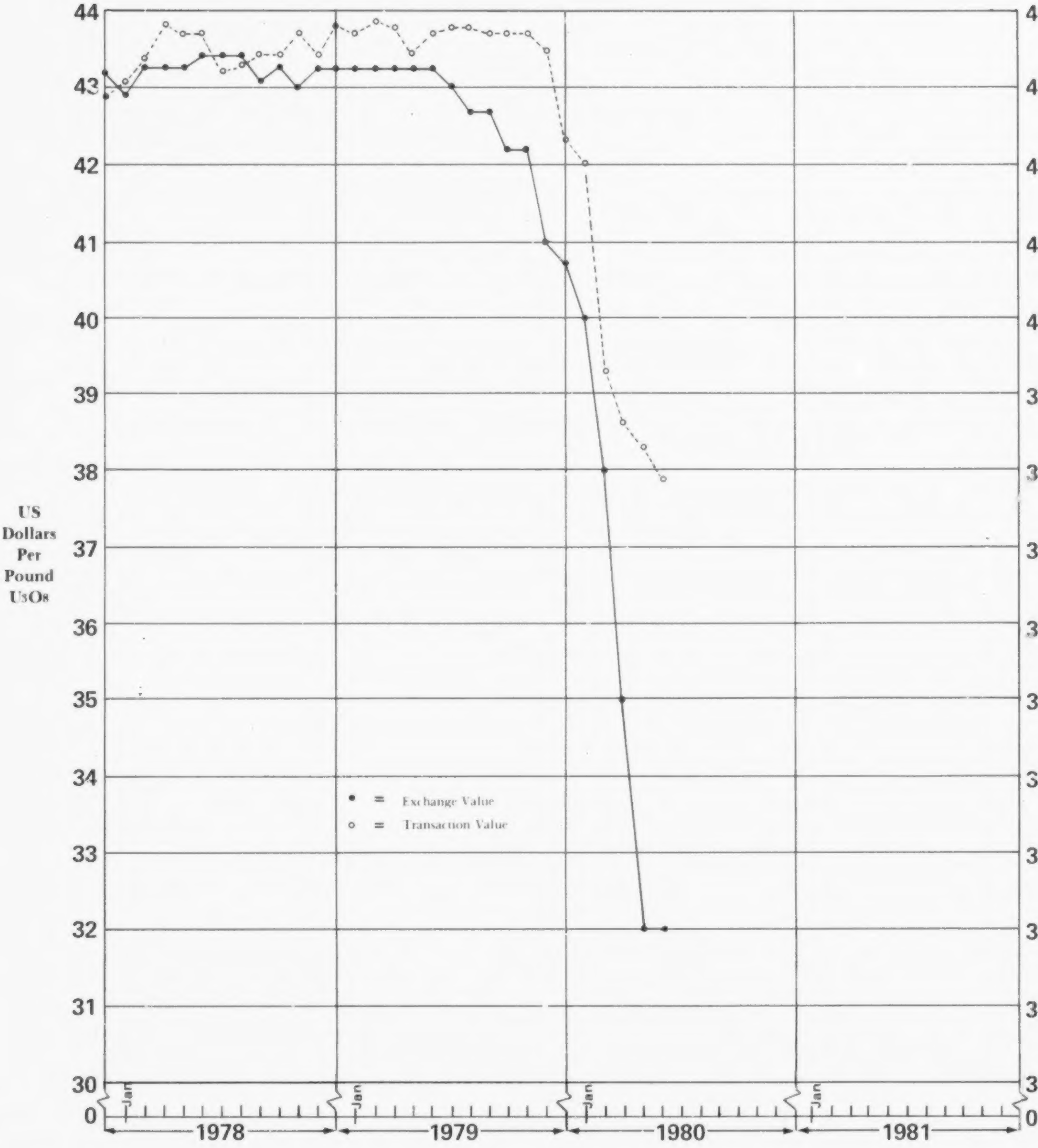
Definition

The Transaction Value is a weighted average price of recent transactions, and is based on prices paid for U_3O_8 in transactions closed within the previous three-month period and for which delivery was scheduled within one year of the transaction date. At least ten transactions totaling at least two million pounds U_3O_8 are included in each calculation, or the sample time is extended as necessary to include these minima. Foreign currencies are converted to US dollars as of the transaction date.

STATISTICAL DATA

EXCHANGE AND TRANSACTION VALUES SINCE JANUARY 1977

Determined as of the last day of the month indicated



STATISTICAL DATA

HISTORICAL EXCHANGE VALUES

Determined as of the last day of the month indicated
(US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1968	–	–	–	–	–	–	–	6.35	6.35	6.40	6.45	6.50
1969	–	6.35	6.10	6.10	6.25	6.25	6.20	6.20	6.15	6.15	6.15	6.20
1970	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.20	6.15	6.15	6.15	6.15
1971	6.20	6.20	6.20	6.20	6.15	6.05	6.00	5.95	5.95	5.95	5.95	5.95
1972	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95
1973	5.95	6.00	6.10	6.20	6.45	6.50	6.50	6.50	6.50	6.50	6.75	7.00
1974	7.70	7.90	8.00	9.00	9.50	10.50	11.50	12.00	12.50	14.00	14.75	15.00
1975	16.00	16.00	18.00	20.00	21.00	23.00	24.70	26.00	26.00	28.50	30.00	35.00
1976	35.20	37.00	39.25	40.00	40.00	40.00	40.00	40.40	41.00	41.00	41.50	41.00
1977	41.35	41.50	41.60	41.60	42.00	42.25	42.25	42.25	42.40	42.75	43.20	43.20
1978	42.90	43.25	43.25	43.25	43.40	43.40	43.40	43.10	43.25	43.00	43.25	43.25
1979	43.25	43.25	43.25	43.25	43.25	43.00	42.70	42.70	42.20	42.20	41.00	40.75
1980	40.00	38.00	35.00	32.00	32.00							

Note: See earlier Nuexco Reports for evolution of the definition of Exchange Value.

HISTORICAL TRANSACTION VALUES

Determined as of the last day of the month indicated
(US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1976	–	–	–	–	39.60	39.70	39.70	40.40	40.30	40.60	40.70	40.70
1977	41.30	41.30	41.40	41.50	42.80	42.90	43.00	42.60	42.50	42.80	42.90	42.90
1978	43.10	43.30	43.70	43.60	43.60	43.20	43.30	43.40	43.40	43.60	43.40	43.70
1979	43.60	43.80	43.70	43.40	43.60	43.70	43.70	43.60	43.60	43.60	43.50	42.30
1980	42.00	39.30	38.60	38.40	37.90							

Note: See Nuexco Report 135 for a discussion of the definition of Transaction Value.

EXCHANGE VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES*

Country	per lb U_3O_8 in Concentrates	per kg U_3O_8 in Concentrates	per kg U in Concentrates
US (dollar)	32.00	70.55	83.19
France (franc)	132.45	292.00	344.34
FRG (mark)	57.02	125.71	148.24
Japan (yen)	7,193	15,857	18,699
Switzerland (franc)	53.18	117.25	138.26
UK (pound)	13.68	30.17	35.58
Australia (dollar)	27.90	61.51	72.53
Canada (dollar)	37.11	81.82	96.49
Niger, Gabon (CFA)	6,601	14,552	17,160
South Africa (rand)	25.15	55.44	65.38

*Calculated using currency exchange rates published in the Wall Street Journal on the last Friday of the month.

LOAN USE CHARGE RATE—7.0%/year

Definition

The Loan Use Charge Rate is Nuexco's judgment of the annual interest rate at which uranium loans could be concluded as of the last day of the month.

Derivation

Nuexco bases the Loan Use Charge Rate upon:

A. Data from recently completed or pending loan transactions.
B. Rates included in firm proposals to borrow or lend.
C. Rates that potential borrowers and lenders have expressed a willingness to pay or accept, but for which Nuexco is not aware of firm proposals.

STATISTICAL DATA

CURRENT TRANSACTIONS*

Nuexco Reference Number	Delivery Period	Approximate Quantity (thousands of pounds, U_3O_8 equivalent)	Approximate Price as percent of Current E.V.	Seller Group	Buyer Group	Remarks
1097	80-81	300 to 600	123	US	Europe	
1101	83-84	300 to 600	105	US	Europe	
1120	81-90	4,000 to 7,000	–	Canada	Far East	Price related to market
1135	80	100 to 300	97	Canada	Europe	

---

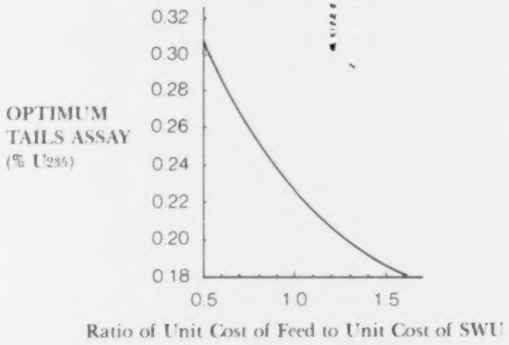
*Transactions listed include not only those in which Nuexco was involved, but also all others of which Nuexco is aware.

STATISTICAL DATA

OPTIMUM TAILS ASSAY

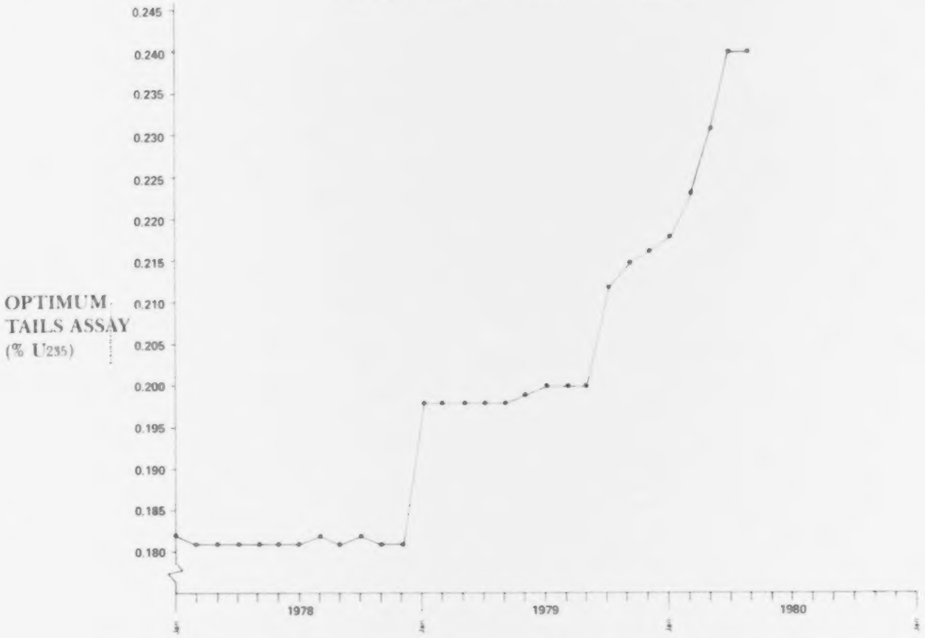
The optimum tails assay is the tails composition at which the cost of enriched uranium is lowest for given costs of separative work (SWU) and natural uranium feed. It depends only on the ratio of the cost of a kilogram of natural uranium in the form of UF_6 to the cost of a kilogram unit of separative work. The US Department of Energy (USDOE) Adjustable Fixed Commitment (AFC) enrichment contract holders have the option, within limits, to specify the transaction tails assay. The transaction tails assay for USDOE Requirements contracts is 0.2 percent U_{235}. For every one-hundredth of one percent increase in the transaction tails assay, uranium consumption increases about two percent.

TAILS ASSAY FOR MINIMUM COST OF PRODUCT*



*From Nuexco Report 138

HISTORICAL OPTIMUM TAILS ASSAY[1]



[1] Based on Exchange Value and USDOE AFC SWU price; interpolated to the nearest thousandth.

STATISTICAL DATA

US GOVERNMENT STATISTICS

	Producer Price Index—Industrial Commodities (1967 = 199)[1]	Consumer Price Index (1967 = 100)[2]	GNP Implicit Price Deflator (1972 = 100)[3]	Gross Average Hourly Earnings of Production or Non-supervisory Workers (US$)[4]		
				Metal Mining (SIC 10)	Primary Non-ferrous Metals (SIC 333)	Chemicals and Allied Products (SIC 28)
Annual Avg. 1970 (5)	110.0	116.3	91.36	3.88	3.87	3.69
Annual Avg. 1971 (5)	114.1	121.3	96.02	4.12	4.15	3.97
Annual Avg. 1972 (5)	117.9	125.3	100.00	4.56	4.59	4.26
Annual Avg. 1973 (5)	125.9	133.1	105.80	4.84	4.98	4.51
Annual Avg. 1974 (5)	153.8	147.7	116.02	5.44	5.63	4.88
Annual Avg. 1975 (5)	171.5	161.2	127.15	6.13	6.24	5.39
Annual Avg. 1976 (5)	182.4	170.5	133.71	6.76	6.87	5.91
Annual Avg. 1977 (5)	195.1	181.5	141.70	7.28	7.67	6.43
Annual Avg. 1978 (5)	209.4	195.4	152.05	8.23	8.56	7.01
Annual Avg. 1979	236.3P	217.4	165.46	9.27	9.50	7.59
Feb 1979	222.5	207.1	–	8.81	9.02	7.32
Mar 1979	225.4	209.1	160.22	8.84	9.11	7.36
Apr 1979	229.0	211.5	–	9.03	9.49	7.50
May 1979	231.6	214.1	–	9.06	9.15	7.47
Jun 1979	234.0	216.6	163.81	9.09	9.44	7.53
Jul 1979	237.5	218.9	–	9.32	9.57	7.60
Aug 1979	240.6	221.1	–	9.38	9.70	7.65
Sep 1979	244.2	223.4	167.20	9.63	9.79	7.73
Oct 1979	249.0R	225.4	–	9.67	9.87	7.82
Nov 1979	250.2	227.5	–	9.79	9.86	7.87
Dec 1979	253.1R	229.9	170.58	9.80	9.92	7.91
Jan 1980	260.3	233.2	–	9.92	10.06	7.96
Feb 1980	265.4	236.4	–	9.93	10.01	7.99
Mar 1980	268.2	239.8	174.51	9.88P	10.22P	8.00P
Apr 1980	270.7	242.5	–	–	–	8.09P

P = Preliminary   R = Revised since last month

(1) US Bureau of Labor Statistics, Washington, D.C.; "Producer Prices and Price Indexes," Table 6 (formerly "Wholesale Prices and Price Indexes"). Producer Price Indexes are revised four months after they are first released to reflect the availability of late reports and corrections by respondents.

(2) US Bureau of Labor Statistics, Washington, D.C.; Consumer Price Index for All Urban Consumers, US City Average, All Items.

(3) US Department of Commerce, Washington, D.C.; Bureau of Economic Analysis, National Income and Wealth Division; "Survey of Current Business," Table A. The GNP Implicit Price Deflator is published quarterly, and seasonally adjusted.

(4) US Bureau of Labor Statistics, Washington, D.C.; "Employment and Earnings," Table C-2. All data based on 1972 revision of SIC Manual. Data for 1970-1976 are adjusted to the March 1977 benchmark. All data for 1977 and beyond are adjusted to the most recent benchmark—March 1978—and are subject to revision from that point forward, with the advent of the next benchmark scheduled for publication in late 1980.

(5) Data for these years, monthly except for the GNP Implicit Price Deflator, appear on pages 4.6 through 4.8 of Nuexco Report 139.

AUSTRALIAN GOVERNMENT STATISTICS

	Price Index of Materials Used in Manufacturing Industry—All Groups (Year 1968-69 = 100.0)[1]	Weighted Average Minimum Weekly Wage Rates—Adult Males Australia Mining and Quarrying (A$)[2]
Annual Avg. 1970(3)	101.4	59.88
Annual Avg. 1971(3)	101.5	65.95
Annual Avg. 1972(3)	105.6	71.26
Annual Avg. 1973(3)	124.4	78.96
Annual Avg. 1974(3)	141.9	108.07
Annual Avg. 1975(3)	150.4	132.55
Annual Avg. 1976(3)	168.4	160.93
Annual Avg. 1977(3)	192.0	179.03
Annual Avg. 1978(3)	215.4	190.04
Dec 1978	235.7	199.28
Jan 1979	246.3	199.79
Feb 1979	253.0	200.00
Mar 1979	264.0	201.45
Apr 1979	273.0	202.27
May 1979	287.5	203.38
Jun 1979	293.8	209.88
Jul 1979	295.8	210.49
Aug 1979	290.8	211.56
Sep 1979	300.0	212.34
Oct 1979	307.0	211.80
Nov 1979	308.0	211.12
Dec 1979	317.0	212.73
Jan 1980	337.7P	214.76P
Feb 1980	343.2P	

P = Preliminary R = Revised since last month

(1) Australian Bureau of Statistics, Canberra; "Price Index of Materials Used in Manufacturing Industry" (Catalogue No. 6411.0), Table 3.
(2) Australian Bureau of Statistics, Canberra; "Wage Rates, Australia" (Catalogue No. 6312.0), Table 1. Figures for the latest twelve months shown are subject to revision.
(3) Monthly data for 1970 through 1978 appear on pages 4.7 and 4.8 of Nuexco Report 138.

STATISTICAL DATA

CANADIAN GOVERNMENT STATISTICS

	Industry Selling Price Index: Manufacturing (D 500000)[1,2] (1971 = 100.0)	Wage-earner Data: Average Hourly Earnings ($C)[3,4]		
		Metal Mining, including milling (SIC 050-059)	Primary Metal Industries, non-ferrous (SIC 296-298)	Chemicals and Chemical Products (SIC 370-379)
Annual Avg. 1977	174.3	8.18	6.50	6.51
Annual Avg. 1978	190.4	8.76	6.82	6.97
Annual Avg. 1979	217.8	9.60	7.35	7.67
Jan 1979	204.8	9.19	7.14	7.29
Feb 1979	208.5	9.24	7.18	7.36
Mar 1979	210.4	9.47	7.20	7.51
Apr 1979	212.8	9.68	7.26	7.63
May 1979	214.5	9.65	7.28	7.61
Jun 1979	216.0	9.49	7.27	7.66
Jul 1979	218.3	9.37	7.34	7.73
Aug 1979	220.0	9.56	7.38	7.77
Sep 1979	223.4	9.75	7.50	7.81
Oct 1979	227.4	9.89	7.54	7.88
Nov 1979	228.1	9.97	7.61	7.91
Dec 1979	230.3R	9.93	7.51	7.89
Jan 1980	238.7R	9.96P	7.57P	7.99P
Feb 1980	240.3	10.11P	7.64P	8.07P
Mar 1980	238.5P	—	—	—

P = Preliminary R = Revised since last month

(1) Statistics Canada, Prices Division, Ottawa; "Industry Price Indexes" (Catalogue 62-011), Table 1. Indexes for the most recent six months shown are subject to revision.

(2) Monthly data for 1973 through 1978 appear on page 4.10 of Nuexco Report 138.

(3) Statistics Canada, Labour Division, Employment and Payrolls Section, Ottawa; "Employment, Earnings and Hours" (Catalogue 72-002), Table 2.

(4) Monthly data for 1977 and 1978 appear on page 4.11 of Nuexco Report 138.

REPUBLIC OF SOUTH AFRICA STATISTICS

	Average Declared Working Costs per Metric Ton of Gold Ore Milled (Rand)[1]	Consumer Price Index[2] (1975 = 100, except where otherwise indicated)
Annual Avg. 1970(3)	7.34	100.3(4)
Annual Avg. 1971(3)	7.88	106.4(4)
Annual Avg. 1972(3)	8.79	113.3(4)
Annual Avg. 1973(3)	10.51	124.1(4)
Annual Avg. 1974(3)	13.18	138.5(4)
Annual Avg. 1975(3)	16.71	157.2(4)
Annual Avg. 1976(3)	19.30	174.7(4)
Annual Avg. 1977(3)	23.87	194.4(4)
Annual Avg. 1978(3)	27.14	137.2
Annual Avg. 1979(3)	30.18	155.3
Feb 1979	–	146.1
Mar 1979	28.60	148.6
Apr 1979	–	149.9
May 1979	–	150.6
Jun 1979	29.44	152.4
Jul 1979	–	157.9
Aug 1979	–	160.2
Sep 1979	30.71	162.1
Oct 1979	–	162.9
Nov 1979	–	163.4
Dec 1979	31.89	164.0
Jan 1980	–	165.4
Feb 1980	–	167.0
Mar 1980	33.65	168.0
Apr 1980	–	170.0

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(1) Chamber of Mines of South Africa, Johannesburg: "Analysis of Working Results," published quarterly.
(2) Republic of South Africa Department of Statistics, Pretoria: "Government Gazette: Consumer Price Index for Urban Areas."
(3) Historical data for 1970 through 1979 appear on page 4.9 of Nuexco Report 140.
(4) April 1970 = 100.00

MARKET OPPORTUNITIES

Market Opportunities are *active* inquiries in the uranium market to buy, sell, borrow or lend. The data presented in this section are in no way intended to be indicative of the entire uranium market for the time period covered.

SUPPLY

Nuexco Reference Number	Delivery Period (Thousands of Pounds U_3O_8)				Remarks
	1980	1981	1982	1983	
Uranium Available for Sale:					
1213	700				
1236					
1274	150				
1284	250				
1286	350	150	150	150	
1306		100	200	200	
1315			200	200	
1325	750				
1338	250				
1346	100				
1377	50				
1392	300				
1394	250				
1403	150				
1417	800				UF_6
1425	100				
TOTALS	4200	250	550	550	
Uranium Available for Loan:					
1175	700				UF_6
1234	700				
1354	600				UF_6
1355	600				
1428	500				
1429	500				
TOTAL	3600				

MARKET OPPORTUNITIES

DEMAND

Nuexco Reference Number	Delivery Period (Thousands of Pounds U_3O_8) 1980	1981	1982	1983	Remarks
Inquiries to Purchase:					
1146		100	200	200	
1335	300				
1357		300			
1381	100	50			
1396	200				
1406	50				UF_6
1408	150				
1410		2000	2000	2000	
1427	400				
TOTALS	1200	2450	2200	2200	
Inquiries to Borrow:					
1220	1000				
1034	200				
1348	350				
1404	250				
1415	600				
TOTAL	2400				

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NUEXCO

JULY 1980 NUMBER 143

Monthly Report on the Uranium Market

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EXECUTIVE SUMMARY & INDUSTRY OVERVIEW
NUEXCO REPORT 143

The **Exchange Value** declined this month to $31.50 per pound U_3O_8, from $32 last month. The market continues to be very thin, and only a few small transactions closed last month. A large amount of material remains available for sale and delivery in the near-term; most of it from inventory holders. However, lower interest rates combined with declining prices have removed some of the pressure on inventory holders to sell, thus many potential sellers are holding out for prices much higher than Exchange Value. The present lack of utility buyers in the near-term market explains the absence of upward price pressure. A few sellers have been willing to reduce prices to near the bid levels of the few buyers in the market. Thus some transactions have been completed, and others are under discussion.

The **Transaction Value** declined slightly to $37.60 per pound U_3O_8, from $37.90 last month. The Transaction Value's failure to move quickly reflects the thinness of the present market. A large number of transactions closed several months ago when prices were higher, and these have dominated the Transaction Value calculation sample for the past few months. More recent, lower price transactions have been relatively small, so old, higher price transactions have remained in the sample, which by definition must include at least ten transactions totalling at least two million pounds U_3O_8.

The weakening uranium market has prompted renewed discussion of a new US import embargo. The **General** section of this Report outlines the reasons Nuexco believes that a new embargo is most unlikely.

A position paper is being circulated in the **US** Department of Energy which provides for a role for the Department in the reactivation of nuclear power in the US. The major conclusions and proposals in the paper are summarized in the **Public and Government Policy** section of this Report.

This month's *Topical Essay* is the latest in a series on various aspects of uranium marketing and procurement. It focuses on UF_6 conversion.

The *Raw Materials* section discusses the Tallahassee Creek uranium district in Colorado.

This Executive Summary may be reproduced for internal distribution.

7/80

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NUEXCO

MONTHLY REPORT ON THE URANIUM MARKET

July 1980 No. 143

MANAGING EDITOR:
JAMES E. VAUGHAN

FOREWORD ii

THE URANIUM MARKET
- PUBLIC AND GOVERNMENT POLICY 1
- GENERAL 1
  - The Embargo Question 1
- AUSTRALIA 4
- CANADA 5
- FAR EAST 5
- UNITED STATES 6
- TRANSACTIONS 6
- PRICING 6
- CONVERSION 7

TOPICAL ESSAY
- MARKETING AND PROCUREMENT: UF_6 CONVERSION 8

COMMENTARY
- DIABLO CANYON 13

RAW MATERIALS
- TALLAHASSEE CREEK URANIUM DISTRICT 14

STATISTICAL DATA
- EXCHANGE AND TRANSACTION VALUES 18
- LOAN USE CHARGE RATE 21
- CURRENT TRANSACTIONS 22
- OPTIMUM TAILS ASSAY 23
- GOVERNMENT STATISTICS 24

MARKET OPPORTUNITIES
- URANIUM SUPPLY 28
  - Available for Sale
  - Available for Loan
- URANIUM DEMAND 29
  - Inquiries to Purchase
  - Inquiries to Borrow
- CONVERSION SUPPLY AND DEMAND 30

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FOREWORD

We are delighted to announce several personnel changes in the Nuexco organization. Kathryn K. Bowen has assumed the position of Manager, Uranium Marketing. Katie's duties in her new position will focus on spot market activity.

W. Scott Hickman has been appointed Manager, Business Development. Scott's new duties will involve developing new activities to supplement Nuexco's conventional business.

Kim M. Peyton has joined the Nuexco staff this month as an Associate. Kim is a recent graduate of Stanford University where she majored in journalism.

Katie Bowen

Scott Hickman

Kim Peyton

URANIUM MARKET

PUBLIC AND GOVERNMENT POLICY

In the **US**, evidence of a recognition of need for a positive nuclear power program have surfaced within the US Department of Energy (DOE). An internal DOE document which provides for a role for DOE in the reactivation of nuclear power is being circulated in the Department. Concurrence or non-concurrence of DOE Assistant Secretaries has been solicited, and the reactions have been mixed.

Conclusions and proposals in that position paper are far-reaching. The major points included:

- Need for a very different way of doing business by and between government and industry. The paper argues that patchwork solutions will always prove inadequate.
- An urgent need exists for a clear, coherent US nuclear power policy. Industry, the administration, congress and the public are confused.
- Use by DOE of *targets* rather than *forecasts* is required. That is, helping to create an end result rather than forecast an end result is necessary.
- Obstacles to progress in nuclear power are in the political arena. DOE programs are centered on the technical arena. DOE should adopt a new role by focusing on that which needs to be done. The most important problem to be overcome with nuclear power in the US is the poor political atmosphere.
- Coal and nuclear power must carry the electrical power burden for the foreseeable future. A middle ground expectation is that electrical demands for the year 2000 will require 450,000 MWe of coal generation, and 400,000 MWe of nuclear power.
- The nuclear supplier industry in the US is capable of meeting the challenge now, but may atrophy in a few years.
- Nuclear power project cycles can and should be reduced from 12 to 6.5 years.
- Regional energy centers should be a key part of the nuclear power program.

The proposed program, if it could be implemented, would have a far reaching impact on the uranium industry. Another 220 nuclear units beyond those already operating, under construction or on order would have to be completed by the year 2000. However the near-term influence on the uranium market is likely to be very small, even if the proposal were to receive Department approval. The chances of the Carter administration's trying to implement the necessary enabling legislation prior to this year's election are negligible, and the most fundamental requirements for change in the US are legislative. Congressional action is necessary to protect private investors from unexpected and uncontrollable government actions. Without such protection, there will likely be no resurgence of the nuclear power business in the US.

Even assuming that some action is taken by the administration in power after the 1980 election, the outcome will not necessarily be positive in the short-term. Public pressure to solve the energy problem is not likely to mount on Congress until more tangible effects of the problem are felt by the public. This may take some time, perhaps years. However the mere existence of a constructive attitude within DOE toward the resurgence of nuclear power, as evidenced by the surfacing of this position paper, must be considered as a positive sign.

GENERAL

The Embargo Question

The original limitation on the use of foreign-source uranium in US reactors, associated with the Private Ownership Act of 1964, has been phased out to the point of commercial insignificance. However, the recent decline in the near-term market price of uranium has stimulated renewed discussion of a new US import embargo.

The embargo question impacts on all segments of the uranium industry. As might be expected, calls for its reimposition have been raised by a few US producers. Some producers are concerned that low-cost foreign production will supplant higher-cost US production. In these discussions, potential US dependence of foreign uranium supply is likened to OPEC and the oil situation.

Many US utilities, on the other hand, are interested in obtaining some portion of their supply from non-US sources. The desire by US buyers to purchase off-shore is closely linked to expectations of prices below what they would have to pay for US supply. Renewed talk of an embargo raises utility concerns about contract terms that might require taking and paying for uranium that could not be used. Some US utilities have made this point in discussions with Australian officials. The utilities are seeking assurance that they would not have to take what they could not use.

URANIUM MARKET

The embargo question is of special concern to governments of exporting nations. Although US uranium consumption is declining as a percentage of the world total, it is and will remain for the foreseeable future the world's largest market. Access to the US market is important to Canada's Saskatchewan sellers as well as Australia's fledgling industry.

The position of the US government on the embargo question is less clear. USDOE has discussed the matter with the Australian government and presumably the governments of other uranium exporting nations. Although the specific content of these discussions is not known, DOE's position, based on its historic interests, is the long-range national security interest of the US in a viable domestic uranium industry. The immediate threat is the cost leadership of non-US producers, and its attendant negative impact on the US production industry.

Like DOE, US utilities wish to maintain a healthy US uranium industry. But they find it difficult to ignore a potential price advantage and are likely to opt for non-US supply if such price advantages are in fact offered. While imports could be limited, or cut off by embargo, by tariff, by informal government-to-government agreements or some combination thereof, such actions are viewed by Nuexco as unlikely. The reasons for this are as follows:

Political problems. A number of important US uranium producers and potential producers are also important international oil companies (e.g. Exxon, Kerr-McGee, Getty, Sohio, Chevron, Arco, Gulf, Conoco, Mobil). An import embargo (which can be expected to increase US uranium prices relative to the rest of the world) would be viewed as benefiting these oil companies at a time when most US politicians would rather have their constituents believe that oil companies are the victims, rather than the beneficiaries, of their actions. Further, there is a substantial political risk in any action which may be viewed by the public in resulting in higher energy prices.

Industry profile. Uranium industry problems will not cause overall business problems for most producing companies. About 45 percent of US uranium is produced by oil companies and about 40 percent by other large organizations in which uranium is a relatively minor activity.

Lack of political clout. About three-fourths of current uranium production in the US comes from New Mexico and Wyoming whose combined population is less than one percent of the US total. Therefore, at the federal level, the political clout of the uranium-producing states is low. Only a small number of voters are affected. Further, uranium is a small business viewed in the context of the total US economy. US production for 1980 is estimated to total about 36 million pounds U_3O_8. If all of this production were sold at today's Exchange Value, the annual industry volume would be only a little more than one billion dollars. The oil industry, by comparison, is well over $100 billion in annual sales. The US uranium production industry is probably too small to receive sustained political attention.

Small balance of payments effect. US uranium consumption is expected to level off at 45 to 50 million pounds U_3O_8 per year in the mid-1980's. At that time, US production is presently expected to yield 25 to 30 million pounds U_3O_8 annually (see Nuexco Report 141). Even if no additional US production comes on line in this period, and net US imports reach 20 to 25 million pounds U_3O_8 annually, the net balance of payments deficit would still be on the order of only one percent of the current US balance of payments deficit for petroleum.

Complicated Foreign Relations. From a practical standpoint, only two exporting nations would be affected, Canada and Australia. The other major producers, South Africa, Namibia and Niger, can be expected to supply only small amounts to the US. Embargoing uranium would likely lead to linkages in negotiations with Canada for increased gas and oil imports into the US. Unilateral imposition of a uranium embargo would not be the simple move it may appear to be on the surface. Hearings prior to legislative action would bring to the surface all such ramifications.

Complexity. Defining what would be embargoed, to what extent, the effective time frame and applicable procedures would require time. Congressional investigations are to be expected prior to government action. A number of facets would be considered. Would present-type restrictions upon utility use merely be extended? Would import measurements apply to gross or net imports? Would demand growth alter allowable quotas? Would trigger mechanisms related to price, volume, etc., be utilized? In other words, the due process required for quality legislation would

URANIUM MARKET

take time. Producers, buyers, consumers, environmentalists, free trade advocates, foreign affairs experts, and numerous others would present points of view. The problem of moderate foreign competition in uranium may not be viewed as sufficient to warrant investment of government and legislative time to the extent required.

Favorable export/import balance. The US currently exports slightly more than it imports. It is not clear how exports would be affected by restrictions on imports. A two-tier price situation might develop that would not necessarily be advantageous to the US producers who wish to sell for export.

No analogy to earlier embargo. The earlier US import embargo was designed to assist the transition from a government-dominated military procurement market to a developing commercial market. No analogy to that situation currently exists.

Immediate problem is not foreign competition. The current dominant forces affecting US producers derive from lower than expected US consumption. Most of that reduction is caused by nuclear power plant delays which, for the most part, relate to licensing. The most effective—and probably the only significantly effective—action the US government could take to improve near-term US uranium market conditions would consist of measures to bring plants on line as early as possible.

OPEC Analogy not applicable. The suggestion that importing of uranium would place the United States in the same position as it is with OPEC vis a vis oil does not stand up under scrutiny. The US does not have the current capability to pump as much oil as it consumes. A cut off in supply or an increase in the price of oil therefore will have an immediate and sharp impact. The situation with uranium is much different. Production capacity exceeds consumption. Uranium ore reserves in the US are large, and U_3O_8 inventories, both public and private, combined with the nature of nuclear fuel cycle will provide adequate reaction time in the event of either a supply cut-off or OPEC-like price behavior on the part of uranium exporting countries.

In summary, the US uranium industry is relatively small; providing import embargo protection appears to be so unrewarding politically as to make it most unlikely even in the face of anticipated cutbacks in US production and the corresponding increases in US net imports.

Coincident with industry concern about a US import embargo, there appears to be some concern among industry participants that the US may, at some time in the future, place an embargo on the export of uranium of US origin. Two conditions, in particular, appear to prompt that concern. First is the belief that exporting would be viewed unfavorably if the US is importing uranium to meet its domestic requirements. Second is the general uncertainty caused by US non-proliferation policies. There are several reasons, however, why it is also unlikely that an export embargo will be implemented.

US non-proliferation objectives. US non-proliferation policy under the Carter Administration was founded on the assumption that granting or withholding of nuclear fuel could induce the conformance of overseas governments with US objectives. This assumption has proved to be inaccurate. The result of unilateral US policy actions have served to increase the interest of non-US users in geographical diversification of supply. An embargo of US-origin U_3O_8 could only further erode US influence.

Free trade favored. US government policies generally favor free trade, and international negotiations usually aim to reduce trade barriers. An export embargo would be inconsistent with those aims. If the US becomes dependent on overseas uranium for part of its requirements, reliability of supply will become more important to US users. Restricting US exports while simultaneously encouraging exports by others would be contradictory.

US security of supply. An export embargo would not appear necessary from a national security-of-supply standpoint. As discussed in Nuexco Report 142, US utilities currently hold inventories equal to about three times annual US consumption. In addition, the US government's strategic stockpile represents several years of US U_3O_8 consumption at the current rate. Therefore, any risk to US security of supply implicit in free trade in uranium would be mitigated by these large stockpiles, since any boycott of the US by uranium-producing nations would clearly not disrupt US electricity production.

URANIUM MARKET

US not a big exporter. Nuexco's estimate of current US export and import commitments for the period 1979-1990 are set forth in Table 1. Although exports in 1979 approached 8 million pounds U_3O_8, they were offset by 6 million pounds of imports. The annual net balance of export-import commitments as seen today does not exceed 2 million pounds in either direction during any year in the period. The balance can be expected to shift towards the import side by the mid-1980's. It is not likely that the total of new export commitments will be large enough to be of true political or economic significance in the US. Consequently, there will be little political driving force for the US to enact an export embargo on uranium.

Table 1

US IMPORT-EXPORT BALANCE[1]
(millions of pounds U_3O_8)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
IMPORTS												
Annual	6.1	5.6	6.6	6.8	5.5	4.9	2.1	2.0	2.0	2.0	2.0	2.0
Cumulative	6.1	11.7	18.3	25.1	30.6	35.5	37.6	39.6	41.6	43.6	45.6	47.6
EXPORTS												
Annual	7.9	7.5	6.3	5.3	4.3	3.2	2.0	1.4	1.4	1.4	1.0	0.9
Cumulative	7.9	15.4	21.7	27.0	31.3	34.5	36.5	37.9	39.3	40.7	41.7	42.6
NET IMPORTS (EXPORTS)												
Annual	(1.8)	(1.9)	0.3	1.5	1.2	1.7	0.1	0.6	0.6	0.6	1.0	1.1
Cumulative	(1.8)	(3.7)	(3.4)	(1.9)	(0.7)	1.0	1.1	1.7	2.3	2.9	3.9	5.0

[1] Includes existing contracts only. Does not include contracts currently under litigation

AUSTRALIA

As noted in Nuexco Report 142, the negotiations leading to the formation of Energy Resources of Australia (ERA) continue to move forward. It is reported that German interests will take up the five percent share declined by the British. Thus, the ownership breakdown of ERA as now contemplated is:

Peko-Wallsend	30.5%
Electrolytic Zinc	30.5%
German Interests	15%
Japanese Interests	10%
Australian Public Float	14%

Reports that a long-term agreement between Ranger and a US utility would be concluded during May 1980, proved premature. Reasons for the delay are not known definitely.

Apparently the proposed obligation of the German and Japanese equity owners is to accept about three percent of annual output for each one percent of equity. Thus, assuming annual output of 6.6 million pounds U_3O_8, this amounts to 200,000 pounds U_3O_8 for each one percent of equity. The Japanese interests would take two million pounds annually and the German interests three million pounds, leaving only 1.6 million pounds to be sold by Ranger to other customers.

However, pre-existing commitments to Japanese utilities (made in the early 1970's), the repayment of loans from the Australian government, and the recent contract with Korea will account for much of the balance of production. The importance of successfully completing the formation of ERA becomes apparent when examined in these terms. If ERA is structured as presently planned, the output of Ranger will be essentially committed from the standpoint of its Australian owners. If ERA were not to go forward, a substantial marketing effort would remain to be accomplished.

Queensland Mines' Narbarlek production facility came on stream early in June, and is already operating at full capacity. Thus, the first increment of

URANIUM MARKET

Australia's new wave of production has been launched. Discovered in 1970, Nabarlek required a full nine years to obtain its various approvals, and only one year to build the mill and commence operations.

CANADA

The predictable theme at the meeting of the Canadian Nuclear Association (CNA) last month was the importance of increasing nuclear generating capacity to provide adequate electrical energy to continue the nation's economic growth. The corollary of using nuclear power for electrical generation is to allow conservation of oil for the things oil alone can do.

An important point brought out at the CNA meeting is that electrical resistance space heating is already cheaper than oil when the electricity is produced by nuclear power. The price of nuclear generated electricity in the Toronto area is currently C$0.023 per kilowatt hour delivered to the residence. Thus heating a typical one thousand square foot Toronto home by electrical resistance heating would cost C$445 annually, if the electricity were generated by nuclear power. The equivalent cost of heating that home with fuel oil on the basis of C$36.00 per barrel of oil (roughly equivalent to US$30.00) is C$1,350 annually.

Of course all electricity produced in the Toronto area is not nuclear, and the average cost of fuel oil in Canada is not yet equal to the average OPEC price. However the above comparison does indicate a trend. In most of the world, including many parts of North America, electrical resistance space heating from nuclear electricity is less expensive than oil heat.

Esso Minerals Canada and its partners Bow Valley Industries and Numac Oil & Gas are continuing studies on the proposed mining and milling complex at Midwest Lake in northern Saskatchewan. Production could begin as early as 1986. The cost of establishing facilities capable of producing 4.4 million pounds U_3O_8 per year is now estimated at C$400 million dollars. Indicated reserves at Midwest Lake are 75 to 80 million pounds U_3O_8; 60 million pounds of nickel and seven million pounds cobalt.

Technical hearings concerning licensing of production at the Key Lake deposit in northern Saskatchewan began last month, and are expected to continue through July. A final report is likely to be issued in September of this year.

FAR EAST

Reflecting less optimistic economic projections, **Korea's** nuclear power program is facing its first substantial delay. While the first seven nuclear units (six Westinghouse PWRs and one CANDU reactor) remain on previously announced schedules, units 9, 10, 11 and 12 will be delayed 3 months, 3 months, 6 months and 12 months respectively. The revised schedule is shown below.

	Completion Date	
Unit	**Previous**	**Revised**
Kori 1	Operating	
Wolsung 1	April 1980	Same
Kori 2	December 1983	Same
Nuclear 5	September 1984	Same
Nuclear 6	September 1985	Same
Nuclear 7	March 1986	Same
Nuclear 8	March 1987	Same
Nuclear 9	December 1987	March 1988
Nuclear 10	December 1988	March 1989
Nuclear 11	March 1989	June 1990
Nuclear 12	December 1989	Dec 1990

Korea's previously announced goal of some 40 reactors in operation by the year 2000 has been viewed for some time as very optimistic. The recent revision is no doubt the first step in establishing a more realistic target.

Despite substantial current inventories and a forward contract position second to no other consumer nation, it now seems certain that a **Japanese** group will purchase ten percent of the equity in Energy Resources of Australia (ERA), the company that will own Ranger. As noted above, this will amount to two million pounds of U_3O_8 annually, once Ranger is in full production. The ten percent Japanese interest will be divided as follows: Kansai 50 percent, Kyushu 25 percent, Shikoku 15 percent, and the trading company C. Itoh, 10 percent. C. Itoh can be expected to sell its share of the output to one of the other Japanese utilities.

Sensitivity in Japan to security of long-term supply was further demonstrated recently by the decision to spend $6 million to construct a prototype plant to recover uranium from sea water. Scheduled for completion in three years, the plant will have a design capacity of only about 25 pounds U_3O_8 annually.

The next step after the prototype plant is apparently the construction of a demonstration plant with an annual capacity in the range of 40,000 to 60,000 pounds. The final step in the plan would involve construction, beginning about 1990, of a commercial facility with an annual capacity in the range of 600,000 to 2,000,000 pounds U_3O_8.

The projected cost of uranium recovery from sea water is so high that it might argue against such an undertaking, and suggest that funds spent on the effort might better be spent acquiring additional uranium inventory. However, in Japan's case, short-term economic considerations tend to be outweighed by desires to increase security of supply in the long term.

UNITED STATES

President Carter exercised his authority under the 1978 US Nuclear Non-proliferation Act (NNPA) to allow the export of enriched uranium for use in India's Tarapur plant. It is expected, however, that factions in both the House and Senate will attempt to override the decision before the 60 legislative days they have to do so expire.

A new state initiative on uranium is on the South Dakota ballot. If passed, it would require a majority vote of all South Dakotans before any uranium mining project would be permitted to begin operations. Currently, three projects in the state could be affected.

Despite the current uranium market conditions, there appears to be no slowdown in uranium development in the state of Texas. US and overseas companies are actively exploring, acquiring leases, and developing in situ leach operations in the state.

In the first half of 1980, reactor delays and deferrals have reduced uranium consumption in the US by more than 29 reactor-years from previous Nuexco estimates. In addition, several plants which are in the early stages of construction are seriously being considered for conversion to coal-fired units.

In its June 11, 1980 decision regarding the aborted Occidental-Bokum deal involving Long Island Lighting company (LILCO) the New York Public Service Commission appears to have reversed its previous position, decided in 1978, regarding captive uranium production of New York utilities. In the prior decision, involving Niagara Mohawk Power Corporation, the utility was required to pass through savings to rate payers, but not losses, from its uranium venture. In the recent deal involving LILCO, the utility would not have been required to pass through savings from its uranium venture to its rate payers.

TRANSACTIONS

Four sales and one loan were concluded this month, but the quantity involved in each transaction was relatively small. The loan was between a European utility which loaned material to a European nuclear contractor. The use charge rate was consistent with the Nuexco Loan Use Charge Rate.

Three of the four uranium sales were for quantities under 50,000 lbs. U_3O_8 equivalent. One of these involved a US utility selling UF_6 to another US utility for immediate delivery. The second entailed the sale of enriched uranium by a US utility to a Canadian nuclear contractor. The third small deal was between a US producer and another US producer. The larger transaction was a sale from a US nuclear contractor to a US producer. The price in each sale was fixed, and all deliveries are scheduled to occur in 1980.

PRICING

The **Exchange Value** declined slightly this month to $31.50, as a few sellers were willing to decrease prices somewhat in an effort to complete transactions. Substantial quantities of material are available for near-term delivery, however the sellers of most of it have been seeking prices well above Exchange Value. Many of the utility sellers that were aggressively attempting to market earlier in the year have recently been reluctant to cut prices. Thus most of the utility material that was for sale remains unsold. With interest rates lower and prices declining, selling pressure appears to be lower for the moment. Nevertheless the material still overhangs the market.

Inquiries to sell uranium for 1980 delivery total about 4.1 million pounds U_3O_8. Of that total, about 40 percent is being offered by uranium producers. Inquiries to purchase for 1980 delivery now total about 750,000 pounds U_3O_8, of which about 40 percent is being sought by utility buyers. It is the lack of utility buyers requiring material for near-term delivery that is mainly responsible for the absence of any upward price pressure on the market.

A few relatively small transactions closed last month, all for near-term delivery. While many sellers are holding out for higher prices, a few have indicated willingness to reduce prices somewhat in order to complete near-term sales. However the market continues to be very thin at this time. For the most part there is a wide gap between bid and offered prices.

Those buyers that received offers during the last 60 days in response to formal invitations for intermediate-term quotations continue to evaluate the responses. There is an apparent and understandable lack of urgency as prices continue to decline. As a consequence, no transactions are now being concluded for other than spot and near-term delivery.

The **Transaction Value** decreased only slightly this month to $37.60 per pound U_3O_8. As in other recent months the Transaction Value was largely influenced by transactions which closed several months ago. This month's sample extended over five months, involving 17 transactions totaling 4.1 million pounds U_3O_8. A large number of these transactions, involving a total of about three million pounds U_3O_8, closed in February 1980 (and were reported in March, five months ago). At that time, prices were generally much higher than today.

One objective in defining the Transaction Value was to maintain a certain amount of inertia in it. The experience of the past few months however, may indicate that the definition provides excessive inertia in a thin market. For example, if the Transaction Value had been calculated using only the past four months (thus omiting transactions reported in March) without regard to the requirement for at least ten transactions and at least two million pounds U_3O_8, the current Transaction Value would have been $30.70 per pound U_3O_8.

CONVERSION

As indicated in previous Nuexco Reports (e.g. Report 138) a secondary market for uranium conversion services is developing. A few transactions have already taken place in this market. In the secondary market, the conversion contractor is not involved directly. Usually the transaction takes the form of a swap whereby UF_6 is exchanged for an equivalent amount of concentrates, plus a cash payment to cover the conversion. The cash payment associated with the swap is thus the conversion price in the secondary market.

The swap involves the following steps:

1. The seller of the conversion services (seller) instructs its conversion contractor (converter) to make UF_6 deliveries as required by the buyer of the conversion services (buyer).
2. The buyer delivers an equivalent amount of concentrates to the seller's account at a location specified by the seller.
3. After completion of the swap, the seller invoices the buyer for the agreed conversion price.

From the standpoint of the seller of the conversion services, the transaction is in effect a "deconversion" of UF_6 (i.e. UF_6 to uranium concentrates).

The *Market Opportunities* section of this Report contains a tabulation of conversion now available for sale, and inquiries to purchase conversion services. The opportunities listed are limited solely to the secondary conversion market. Nuexco's judgment as to the price at which transactions for conversion services in the secondary market could be concluded as of June 30, 1980, based on past transactions and current supply and demand for conversion services, is $1.50 per pound U in UF_6.

TOPICAL ESSAY

MARKETING AND PROCUREMENT: UF_6 CONVERSION

Introduction

Chemical converison of natural uranium concentrates into the form of uranium hexafluoride (UF_6) is a necessary part of the light water reactor fuel cycle. This is because uranium in the form of UF_6 is the required feed for all existing commercial enrichment facilities. Thus conversion is an integral component in both the marketing and procurement side of the natural uranium market. The conversion plant is often the delivery location under uranium supply contracts, or it is at least the ultimate destination upon shipment by the seller. Usually the seller of the uranium concentrates is paid on the basis of the weighing, sampling and analysis performed after arrival at the conversion plant.

In addition to their intended function, the conversion contractors' facilities have largely served as the physical "surge tank" for the industry's natural uranium inventories. This was not by design, but given the nature of most uranium supply contracts, which usually call for delivery at or shipment to the converter, and given that final payment to the producer is based on weighing and analysis done at the conversion plant, it is not surprising that so much of the inventory is at conversion plants. It is estimated that about 72 percent of the current US-owned commercial inventory of natural uranium is located at the two US conversion plants, with most of the balance at USDOE. Two commercial storage facilities are also licensed in the US, but significant amounts of US-owned inventory have not yet been moved into these facilities.

Weighing, Sampling and Assaying of Concentrates

When natural uranium concentrates arrive at the conversion plant, it is first necessary to determine how much material has been delivered, and whether the material is acceptable for conversion. Thus the first thing that happens to the concentrates is weighing, sampling and moisture determination. Later the samples which were taken are sent to a laboratories where chemical analyses are performed. The following paragraphs describe this process.

Natural uranium concentrates are normally shipped in open head 55 gallon steel drums. Figure 1 is an overview of a concentrates storage area at a US conversion facility. The extent of the uranium inventory physically located at the facility is apparent from this photograph. Figure 2 shows a forklift positioning a lot for weighing and sampling. Individual drums move on a conveyor to a scale where the gross weight of each drum is recorded. After weighing, an operator removes the lid and a drum dumper, shown in Figure 3, inverts the drum, and the concentrates are dumped into a hopper below the dumper. A portion of the stream of concentrates falling into the hopper are cut out to form a sample. (This is the *falling stream* method of sampling.) After the drum is dumped the residual concentrates are removed from it by vacuuming (Figure 4). After dumping and vacuuming, the lids are replaced on the empty drums, and the tare weight of each drum is recorded, thus furnishing the net weight of concentrates in each drum. When weighing and sampling are completed, the concentrates are retransferred from the hopper to the empty drums, as shown in Figure 5.

The total of all sample cuts taken from the drums of a given lot are further split to acquire the amount necessary for the *lot sample*. Moisture determination is then made in the on-site laboratory and the *sample jars* are prepared from the lot sample. Figure 6 shows a lab technician preparing the lot sample for moisture determination of the lot and for obtaining the required number of sample jars. Usually six sample jars are prepared for each lot. Two are sent to the uranium producer and two are sent to the converter for analysis and assay exchange. Two are retained for later umpire use, if necessary. The analysis of the sample jars along with the net weights are used to determine the quantity and properties of the lot.

The conversion contract contains provisions which govern the procedure for weighing, sampling, assaying, moisture determination, and umpire analysis. The purpose is to allow for simple and orderly agreement among the producer, user and converter as to the quantity of uranium delivered and whether the concentrates meet specifications. If the concentrates meet specifications for acceptance, the converter credits the storage account of the producer, or the conversion account of the user, as the case may be, for the agreed upon quantity of uranium in the lot. If the properties of the lot are such that any surcharges are required, these are usually paid directly by the producer to the converter.

TOPICAL ESSAY

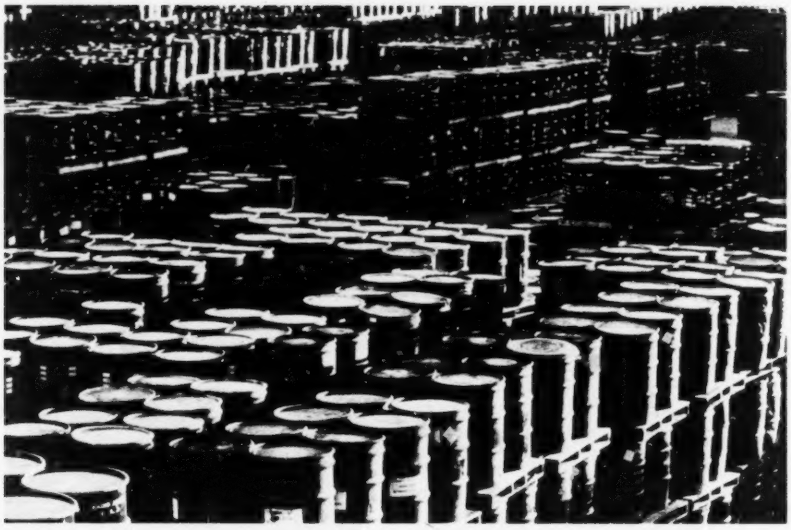


Figure 1
OVERVIEW OF CONCENTRATES STORAGE AREA AT A US CONVERSION FACILITY.

Figure 2
MOVING CONCENTRATES INTO THE WEIGHING AND SAMPLING PLANT ADJACENT TO THE CONVERSION FACILITY.

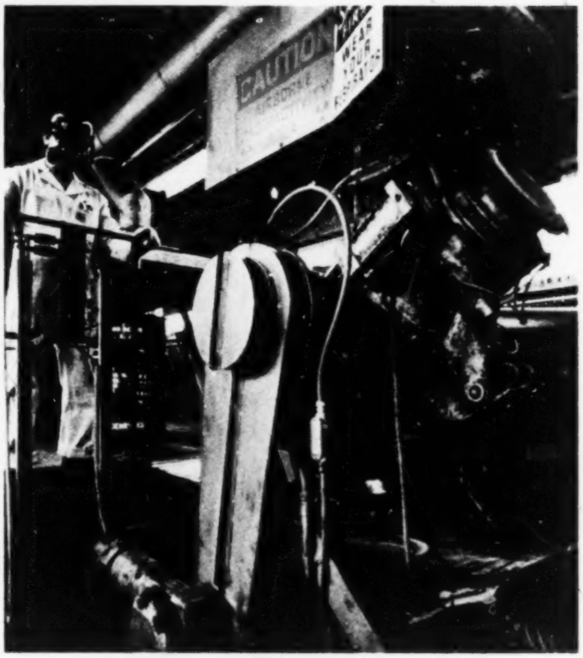


Figure 3
UPENDING AND EMPTYING OF DRUMS AFTER GROSS WEIGHING. SAMPLING IS ACCOMPLISHED AS MATERIAL ENTERS THE HOPPER BELOW.

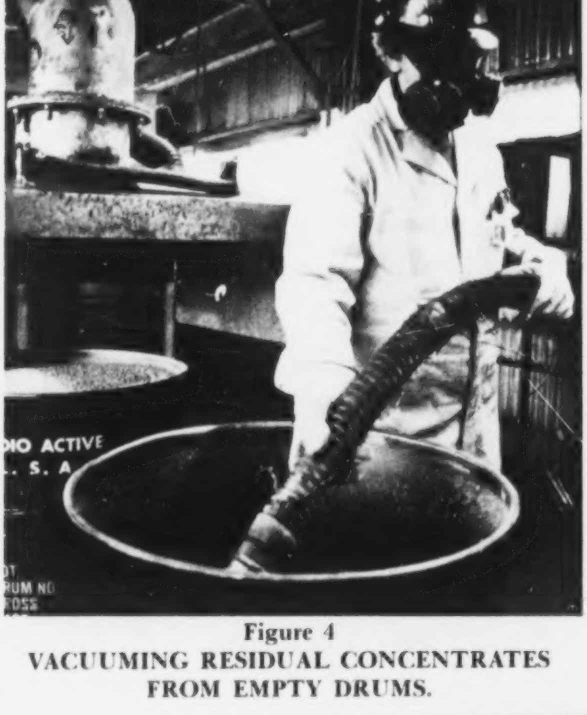


Figure 4
VACUUMING RESIDUAL CONCENTRATES FROM EMPTY DRUMS.

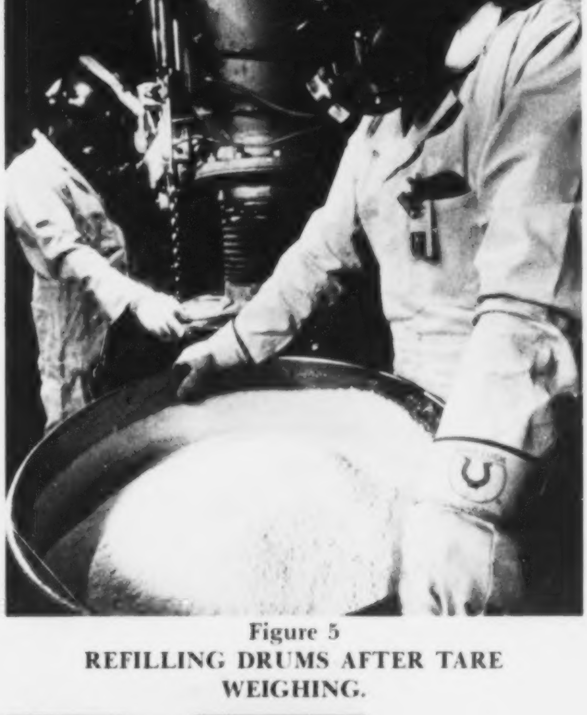


Figure 5
REFILLING DRUMS AFTER TARE WEIGHING.

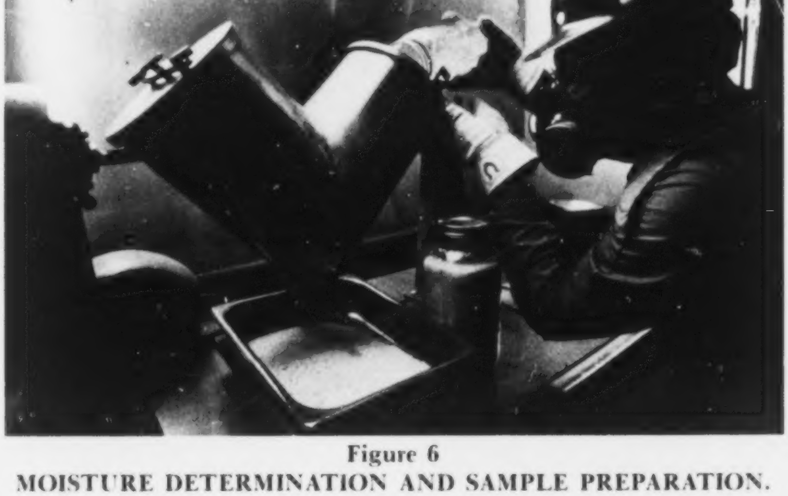


Figure 6
MOISTURE DETERMINATION AND SAMPLE PREPARATION.

TOPICAL ESSAY

The Conversion Contract

The contract between the user and the conversion contractor is of course aimed principally at the chemical conversion of natural uranium concentrates into UF_6. There are a number of other aspects of the contract, however, which often become important during the administration of the contract.

Title and risk of loss: Risk of loss in the uranium usually passes to the conversion contractor upon delivery of the concentrates, and remains with the converter until delivery of the UF_6. That is, the converter has risk of loss while it has possession. Most conversion contracts specify, however, that the user will retain title to the uranium at all times during which it is in the possession of the converter. While this requirement may seem innocuous on its face, it has often become a problem when a user has desired to sell or lend uranium while it was physically located at a conversion plant. The conversion contractor has sometimes held that the user does not have the contractual right to sell or lend material located at the facility under a conversion contract, due to the presence of the contract clause regarding the user's retaining title. Others have expressed the opinion, however, that the clause on title is intended to apply only as between the converter and the user, and is in no way intended to impede the free marketability of the material while it is in the possession of the converter.

Comingling and right to preproduce: Most conversion contracts contain a provision which allow the converter to comingle the user's uranium with other uranium in the plant, and to preproduce UF_6 at any time after acceptance by the converter of the user's concentrates. This provision is intended to allow the converter to operate its plant in a relatively continuous and therefore efficient manner. One result of this provision is that, even though the user maintains title to the material, it does so in the form of a bookkeeping entry. That is, there is no specific material physically identified to the user's contract until such time as delivery of UF_6 is actually made. This feature, present in most conversion contracts, has also been an obstacle at times when users desire to sell or lend material located at a conversion plant. Since there is no material physically identified to the contract, the user must depend on the conversion contractor to make an accounting transfer from that of the user to that of the buyer or borrower. This requires both that the converter actively cooperate in the sale or loan transaction and that the buyer or borrower have an agreement with the converter under which the material purchased or borrowed can be received.

Some conversion contracts do not grant the converter the right to comingle and preproduce. Under such contracts, the user's material is physically segregated and remains identified to the user's contract until it enters the conversion pipeline.

Book transfers: Many uranium producers have agreements in effect with conversion contractors under which the producer can deliver concentrates to the converter and retain title to the material. Under these agreements, usually called *storage agreements*, the producer can deliver the material, have it weighed, sampled and assayed, and reach agreement with the converter on *final pounds* of material delivered. Thereafter, the producer can advise the converter to make a book transfer of final pounds to its customer's conversion account.

Delivery of UF_6: The conversion contract normally specifies that UF_6 is to be delivered to the facilities of a uranium enrichment contractor. The UF_6 will usually have to meet a set of UF_6 physical specifications. The converter will normally provide UF_6 cylinders in the case of a standard delivery to an enrichment plant.

Storage: Traditionally, when the conversion contract has provided the converter with the right to comingle and preproduce, the contract has been silent on storage charges for uranium in the form of concentrates. However there are now indications of a movement by the converters toward restricting unlimited storage of concentrates. The reasons for this include the liability and property insurance considerations of the large amounts of material now in the possession of the converter.

When a UF_6 delivery is called for under the conversion contract, and the user does not have a corresponding requirement for a natural UF_6 delivery at the enrichment plant, some accommodation must be made between the user and the converter. This will take the form of either a contract modification, or an arrangement to store the UF_6, on the converter's site or elsewhere. (Sometimes the conversion contract will include a limited duration of UF_6 storage by the converter.) If storage is arranged at a site other than that of the converter, a problem arises in that the usual delivery point under the conversion contract is an enrichment plant. Therefore alternate delivery arrangements must be agreed to by the converter and the user. Also quantities and properties of UF_6 delivered by the converter are normally determined in connection with weights and assays made by the enrichment contractor. If third party storage is arranged, some accommodation needs to be made between the user and the converter on the determination of UF_6 weight and assay and the converter's warranty of specifications at the time of ultimate delivery of the UF_6 for enrichment. Finally, regardless of where UF_6 is stored, lease or purchase of UF_6 storage cylinders must be arranged.

COMMENTARY

DIABLO CANYON

The fact that the Pacific Gas and Electric Company has been granted substantial rate increases during 1980 has not escaped the attention of the news media in California. However, one of the principal contributing factors making these rate increases necessary has apparently not yet been detected by reporters. It is namely the continuing delay in the operation of the Diablo Canyon nuclear power plant.

PG&E's Diablo Canyon plant, located near San Luis Obispo, consists of two 1150 MWe PWR units. Both units are essentially complete and ready to begin startup operations. However, startup has been delayed as the result of the licensing logjam at the NRC, and continued opposition on the state level by the administration of California Governor Jerry Brown. If the Diablo Canyon plant were operating, PG&E could avoid burning about 20 million barrels of oil per year. At an assumed price of $30 per barrel (recent spot prices have been much higher), the annual cost of burning that oil is $600 million.

In contrast, the annual nuclear fuel cycle cost for the Diablo Canyon plant to produce an equivalent amount of electrical power would be $80 million. Thus PG&E and its rate payers would save at least $520 million per year in fuel cost if Diablo Canyon were allowed to operate. The PG&E service area includes a population of nine million people. Continued delay in Diablo Canyon startup in effect costs each PG&E rate payer $58 per year, or $232 annually for a family of four.

In addition to the fuel cost *now* being paid by the consumer, the cost of the idle plants will also eventually have to be passed on to the rate payer. The annual financing charges (in the hundreds of millions of dollars) for the idle plant are currently not in rate base. But these financing charges are accrued, and they will ultimately be capitalized and paid by future consumers of electricity.

Normally the news media is quick to discover and expose bilking of the consumer, especially when it involves such large amounts of money. Its failure to do so in the case of Diablo Canyon is so glaring that is is difficult to understand how it could happen.

TALLAHASSEE CREEK URANIUM DISTRICT

Introduction

A number of small uranium occurrences were discovered in the Tallahassee Creek area of Colorado during the early 1950's. However, the area did not attain "district status" until 1977 when Cyprus Mines Corporation announced that it had discovered about 30 million pounds U_3O_8 contained in two ore deposits on Middle Tallahassee Creek. At the time the discoveries were announced, they represented one of the more significant developments in the US uranium industry in several years.

A new surge of exploration activity followed the Cyprus announcement, and by early 1978 between 15 and 20 companies had acquired about one million acres in the district for the purpose of uranium exploration.

Tallahassee Creek is located about 20 miles northwest of Canon City in Fremont County, Colorado. The principal area of interest to exploration groups is a sedimentary sequence of Tertiary formations filling a structural trough referred to as Echo Park Graben. The trough separates the uranium district from South Park Basin, the southernmost of three structural basins situated between the Front Range of the Rocky Mountains to the east, and the Park Range and Sawatch Range to the west. Numerous uranium occurrences have been discovered throughout the intermontane basin areas, however past production and presently existing ore reserves are primarily limited to the Tallahassee Creek district. The deposits discovered by Cyprus represent the largest known occurrence of uranium in sedimentary rocks in the Colorado Front Range region.

Exploration and Development

Uranium was first discovered in the Tallahassee Creek area in 1954 by prospectors using hand-held radiometric detection instruments. The first discoveries were located on radiometric anomalies in soil cover, rather than rock outcropings. Subsequent trenching revealed uranium mineralization within a few feet of the surface. A prospecting rush followed, which resulted in the location of a number of anomalies. At least 15 small ore deposits were soon discovered at depths to 100 feet below the surface. The principal ore minerals in the deposits were uraninite and autunite, associated primarily with carbonaceous material, pyrite and calcium carbonate.

Almost all the mineralization discovered in the 1950's occurred in two depositional environments within the upper portion of the Tallahassee Creek Conglomerate of Oligocene-Miocene Age. In the upper 30 feet of the formation, the ore zones were found as irregular accumulations in a fine to coarse conglomerate consisting of rhyolite, andesite and Precambrian granitic boulders, with a fine matrix of volcanic ash, tuff and claystone. Rock alteration was common, and in this oxidizing environment, the ore minerals present consisted of autunite and uraninite.

The deeper ore deposits were tabular and usually elongated in the direction of sedimentary trends. The deposits were found near the base of a tuffaceous sandstone unit, which is in unconformable contact with the lower Echo Park Formation and/or Precambrian rocks, both of which had been subjected to extensive erosion and block faulting. Uranium mineralization is closely assocated with tuffaceous zones where the formation is at maximum thickness due to channel-filling of pre-Tallahassee Creek Conglomerate topography. The uranium-bearing host formation is the Ash Fall unit of the Tallahassee Creek Conglomerate. At least two of the small uranium deposits were found in Echo Park Formation. The predominant ore mineral was uraninite with minor amounts of autunite, and the accessory minerals, pyrite, hematite and limonite. Carbonaceous material is an important constituent in the host rock. It is considered to be the primary chemical control relating to localization of uranium mineralization.

The largest of the ore deposits contained about 25,000 tons of ore; the smaller deposits contained less than 1,000 tons. Property development and mining occurred principally during the period from 1957 through 1960, but continued sporadically through 1972. Total production from the district through 1972 was about 96,000 tons of ore at an average grade of 0.25 percent U_3O_8. All mining was by open pit methods. The ore was shipped to processing mills at Canon City and Gunnison, Colorado.

The first deep exploration drilling in the district was initiated in 1968. The main exploration target was the lower portion of the Echo Park Formation which is in unconformable contact with Precambrian basement rocks throughout much fo the Echo Park Graben area. Drill depths to 2,000 feet revealed the existence of Echo Park sediments filling broad, meandering paleochannels eroded into the Precambrian rocks. Anomalous uranium mineralization was noted in many drill holes, however grade and thickness of the mineralization were insufficient for development at the time. Exploration activity virtually ceased by early 1970.

The district remained dormant to new exploration activity until 1974 when Cyprus Mines Corporation began exploration in the High Park area. After moderate exploration success at High Park, Cyprus shifted exploration activity to the Tallahassee Creek locality. The first significant mineralization to be discovered was located on a trend extension of the Picnic Tree Mine along Middle Tallahassee Creek. The Picnic Tree ore deposit had been discovered and mined during the 1950's. Cyprus eventually drilled out about 3.5 million pounds U_3O_8 along an east-west paleochannel in the Ash Fall unit of the Tallahassee Creek Conglomerate. The mineralization was found on a remnant of an upraised fault block at depths up to 250 feet. The predominant ore mineral is uraninite. The average grade of the ore is 0.08 percent U_3O_8.

Continued exploration eventually led to the discovery of the Hansen ore deposit between one and two thousand feet north of the Picnic Tree fault block. The Hansen orebody is a stratiform deposit that occurs in an interbedded sandstone, mudstone and pebble to boulder conglomerate facies of the lower Echo Park Formation. The top of the ore deposit is at a depth of about 500 feet below the surface; the bottom is at about 750 feet. The mineralization is interbedded with barren siltstone, sandstone and conglomerates, and is irregular in lateral extent. The orebody appears to have been deposited in a geochemical cell-like system and is similar in some respects to Tertiary roll-front deposits in Wyoming. Figure 7 shows the location of the Hansen and the Picnic Tree uranium deposits, and their relationship to subsurface faulting.

Total uranium reserves in the deposit are now estimated at 26.5 million pounds U_3O_8, at an average grade of 0.08 percent U_3O_8. Uraninite and coffenite are the only uranium minerals present. There are two theories on the source of the uranium. It was leached either from Precambrian rocks or from the thick Oligocene and Miocene volcanic tuff sequence overlying central Colorado. In either case, the uranium was then carried by groundwater and precipitated in the favorable host rock.

In 1978, Cyprus Mines sold 49 percent of its interest in the two ore deposits and adjoining properties to Wyoming Mineral Corporation. Under the agreement, Cyprus is to serve as operator of the joint venture during exploration, development and production within the project area. Applications for permits required for mining and milling operations at the Hansen & Picnic Tree deposits have been filed with state and federal agencies. If the project proceeds, it is estimated that stripping could begin on the Hansen deposit in 1981, with first ore production in 1983. Development of the Picnic Tree deposit would begin later. Construction of the mill and tailings disposal dams could begin in 1981 if permits are received in a timely fashion, with initial yellow-cake production starting in 1984.

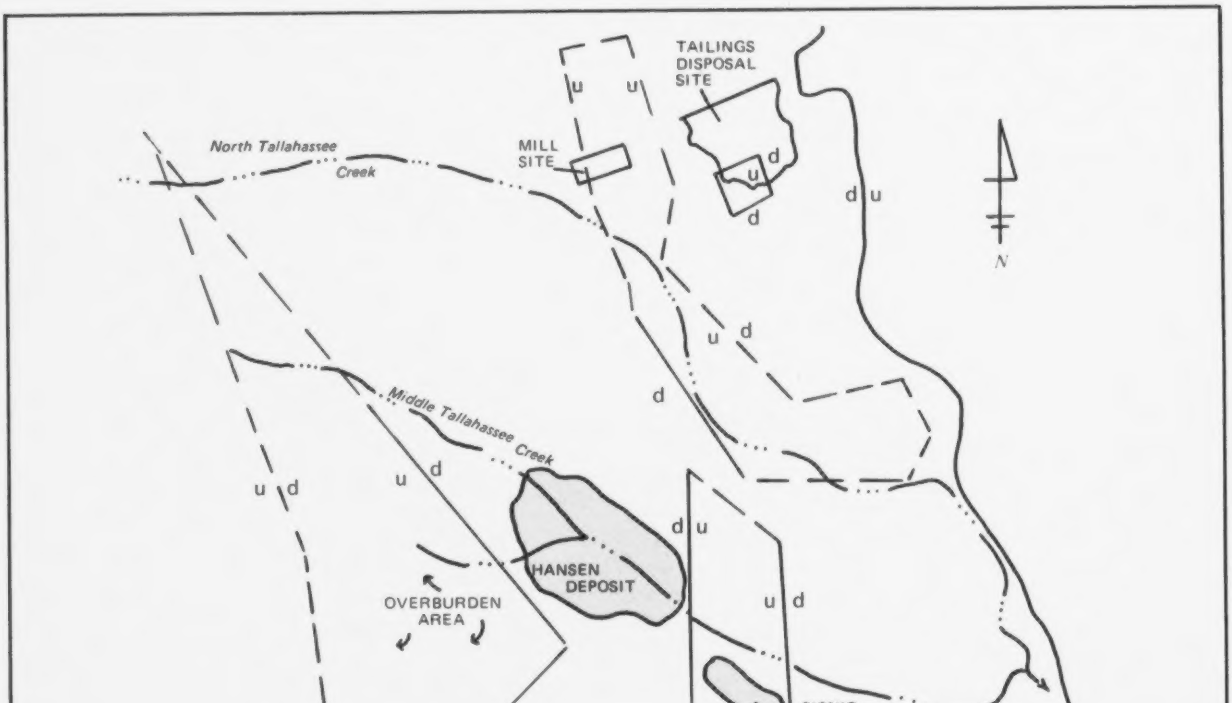
District Geology

The Echo Park Graben is a structural feature which formed in the early Tertiary Period, probably during Paleocene time. Erosion was intense during, and after, structural activity. Practically all Paleozoic and Mesozoic rocks were eroded away, and deep channels were cut into the Precambrian basement rock. This was followed by rapid deposition of Tertiary formations which eventually filled the graben with about 2,500 feet of sediments and volcanic flows.

The rock formations in the district are divided into four geologic age groups—Precambrian, Eocene, Oligocene-Miocene and Pleistocene to Recent.

Precambrian: The Precambrian underlies the entire Tallahassee Creek district. It consists of both plutonic and metamorphic rocks. The plutonic rocks, probably the Pikes Peak granite, intruded older rocks to form highly metamorphosed gneisses and schists. The rocks were later intruded by granite, pegmatite and finally, quartz veins. The structural complexity of the sequence is related to the Laramide orogeny of Late Cretacous and early Tertiary time, and later formation of the Echo Park Graben. The graben forms the eastern and western boundaries of the Tallahassee Creek District.

Eocene: The Eocene time marked the beginning of a long period of fluvial deposition and extensive erosion in the district. Eocene sediments, which may be at least 1300 feet thick, began filling the graben ara before the end of structural activity. Topographic


TAILINGS DISPOSAL SITE
MILL SITE
North Tallahassee Creek
Middle Tallahassee Creek
HANSEN DEPOSIT
OVERBURDEN AREA
PICNIC TREE DEPOSIT
South Tallahassee Creek
u
d
N
URANIUM DEPOSIT
SUBSURFACE FAULTING – DASHED WHERE INFERRED
Grand Junction
Denver
TALLAHASSEE CREEK DISTRICT
Colorado Springs
Canon City
Pueblo

Scale: 1 inch = 1 mile

Adapted from AAPG Colorado Uranium Guidebook, June, 1980

INDEX MAP OF COLORADO SHOWING LOCATION OF THE TALLAHASSEE CREEK URANIUM DISTRICT

Figure 7
LOCATION MAP OF THE TALLAHASSEE CREEK URANIUM DEPOSITS, TALLAHASSEE CREEK URANIUM DISTRICT, FREMONT COUNTY, COLORADO

lows in the Precambrian rock began filling with boulder conglomerates derived by residual weathering of steep graben walls. This represents the fanglomerate facies of the Echo Park Formation. As the graben began to fill, flowing streams eroded the fanglomerates and deposited thick sequences of sediments consisting of widely disbursed fine to coarse arkosic sandstones, interbedded with lenses of siltstone, claystone and pebble to boulder conglomerates. Carbonaceous material is more common to this sequence than it is to the fanglomerates. This type of deposition forms approximately 60 to 70 percent of the total Echo Park Formation.

Rapid erosion occurred simultaneously with deposition. Early sediments were reworked and redeposited as part of the constant changing sedimentary cycle. Thickening of sediments is significant where deposition occurred in stream channels which had eroded into older Echo Park sediments and Precambrian rocks. The thicker segments of the lower Echo Park fluvial system is the host for uranium mineralization at the Hansen ore deposit and at least two small deposits discovered in the 1950's.

Oligocene to Miocene: The oldest volcanic unit is the Wall Mountain Tuff of Oligocene Age. Deposition was widespread throughout the entire region. It is a rhyolitic, ash-flow, welded tuff from 0 to 150 feet thick. At Tallahassee Creek, the tuff overlies the Echo Park Formation, but it is commonly in unconformable contact with Precambrian rocks where the Echo Park was removed by erosion. The Wall Mountain Tuff was also subjected to extensive erosion.

The Tallahassee Creek Conglomerate, also of Oligocene Age, overlies the Wall Mountain Tuff. The formation is divided into three members which have a combined thickness of about 400 feet. The oldest member is the Tallahassee Creek Conglomerate which is up to 350 feet thick. It consists of coarse to boulder sized volcanic debris with clay and sand matrix. Interbedded tuffaceous and arkosic sandstones and claystones are common, and offer evidence of breaks in the rapid deposition of coarse material.

The middle member is the Hansen Andesite-Latite. It has been identified only locally within the area of the Hansen deposit. It is characterized by a porphyritic texture of the andesite or latite, and partial alteration of phenocyrsts to clay. Formation thickness is up to 45 feet.

The upper unit is the Tallahassee Creek Ash Fall Member. It is almost always present as the upper zero to ten feet of the Tallahassee Creek Conglomerate. It consists of kaolinitic and bentonitic claystone with occasional tuffaceous sands and pebble conglomerates. During deposition of the Ash Fall, stream erosion was common. The ash was reworked and redeposited with carbonaceous material on a highly irregular surface. The Ash Fall Member is the host for uranium mineralization at the Picnic Tree deposit as well as the majority of deposits discovered in the 1950's.

The Thirty-nine Mile Andesite overlies the Tallahassee Creek Conglomerate. It was deposited over a broad area of central Colorado. It varies in thickness from zero to 800 feet and consists of highly altered and brecciated andesite. The lower portion contains interbedded tuffaceous waterlain sediments, and unconsolidated basal volcanic breccia. The upper portion contains several ash flows and volcanic deposition, all of which are part of the greater Thirty-nine Mile volcanic field. The combined sequence marks the end of Oligocene and probably Miocene volcanic deposition.

Pleistocene to Recent: Structural activity was renewed during late Miocene and probably Pleistocene time. Block faulting elevated the formations to their presently existing levels. This is well illustrated by the position of the Picnic Tree ore deposit with relation to the Hansen ore deposit as shown in Figure 7. The present surface topography within the district was developed primarily by erosion and downcutting of Tallahassee Creek. Recent gravels and aluminum were derived and deposited by this action.

STATISTICAL DATA

EXCHANGE VALUE—31.50/lb U_3O_8
Determined as of June 30, 1980

Definition

The Exchange Value is Nuexco's judgment of the price at which transactions for significant quantities of natural uranium concentrates could be concluded as of the last day of the month.

Derivation

Nuexco bases the Exchange Value upon:

A. Data from recently completed transactions.
B. Data from pending transactions.
C. Firm bids to buy and firm offers to sell.
D. Prices purchasers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy, and prices sellers have expressed a willingness to accept, but for which Nuexco is not aware of firm offers to sell.

Comments

Nuexco does not consider the following in determining the Exchange Value:

A. The price of uranium delivered or to be delivered under old contracts.
B. The price of uranium delivered in connection with contract renegotiations or other than arm's length transactions.

TRANSACTION VALUE
Determined as of June 30, 1980

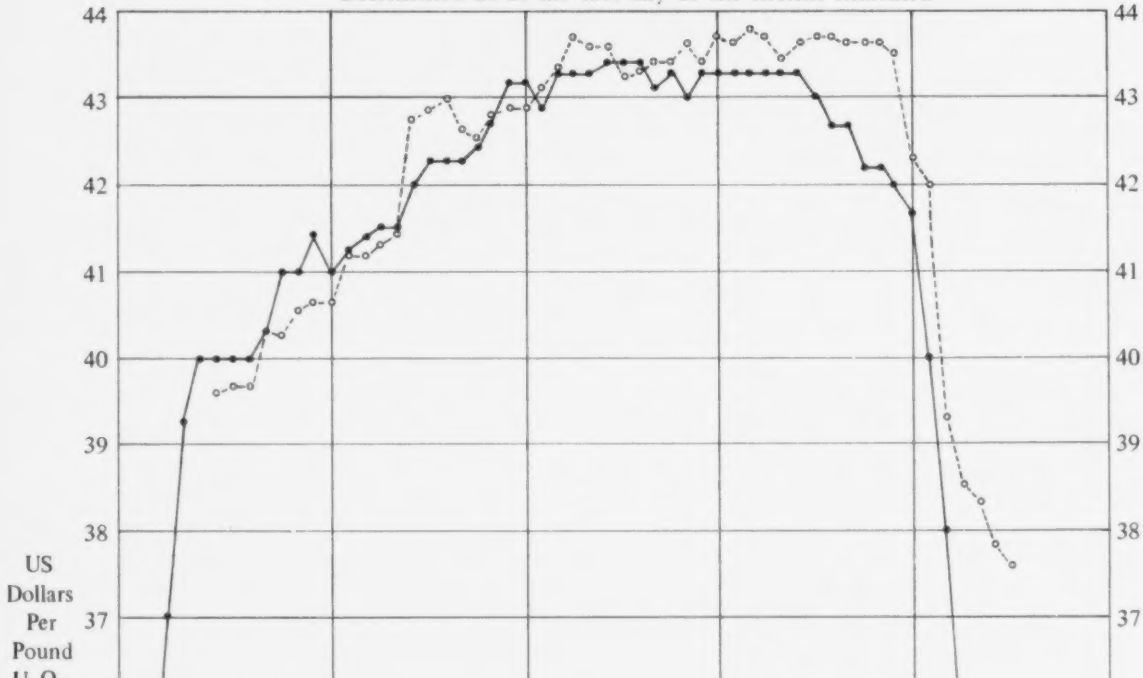
$/lb U_3O_8	Millions of Pounds	Number of Transactions	Number of Months
37.60	4.1	17	5

Definition

The Transaction Value is a weighted average price of recent transactions, and is based on prices paid for U_3O_8 in transactions closed within the previous three-month period and for which delivery was scheduled within one year of the transaction date. At least ten transactions totaling at least two million pounds U_3O_8 are included in each calculation, or the sample time is extended as necessary to include these minima. Foreign currencies are converted to US dollars as of the transaction date.

STATISTICAL DATA

EXCHANGE AND TRANSACTION VALUES
SINCE NOVEMBER 1975
Determined as of the last day of the month indicated



STATISTICAL DATA

HISTORICAL EXCHANGE VALUES

Determined as of the last day of the month indicated
(US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1968	–	–	–	–	–	–	–	6.35	6.35	6.40	6.45	6.50
1969	–	6.35	6.10	6.10	6.25	6.25	6.20	6.20	6.15	6.15	6.15	6.20
1970	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.20	6.15	6.15	6.15	6.15
1971	6.20	6.20	6.20	6.20	6.15	6.05	6.00	5.95	5.95	5.95	5.95	5.95
1972	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95
1973	5.95	6.00	6.10	6.20	6.45	6.50	6.50	6.50	6.50	6.50	6.75	7.00
1974	7.70	7.90	8.00	9.00	9.50	10.50	11.50	12.00	12.50	14.00	14.75	15.00
1975	16.00	16.00	18.00	20.00	21.00	23.00	24.70	26.00	26.00	28.50	30.00	35.00
1976	35.20	37.00	39.25	40.00	40.00	40.00	40.00	40.40	41.00	41.00	41.50	41.00
1977	41.35	41.50	41.60	41.60	42.00	42.25	42.25	42.25	42.40	42.75	43.20	43.20
1978	42.90	43.25	43.25	43.25	43.40	43.40	43.40	43.10	43.25	43.00	43.25	43.25
1979	43.25	43.25	43.25	43.25	43.25	43.00	42.70	42.70	42.20	42.20	41.00	40.75
1980	40.00	38.00	35.00	32.00	32.00	31.50						

Note: See earlier Nuexco Reports for evolution of the definition of Exchange Value.

HISTORICAL TRANSACTION VALUES

Determined as of the last day of the month indicated
(US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1976	–	–	–	–	39.60	39.70	39.70	40.40	40.30	40.60	40.70	40.70
1977	41.30	41.30	41.40	41.50	42.80	42.90	43.00	42.60	42.50	42.80	42.90	42.90
1978	43.10	43.30	43.70	43.60	43.60	43.20	43.30	43.40	43.40	43.60	43.40	43.70
1979	43.60	43.80	43.70	43.40	43.60	43.70	43.70	43.60	43.60	43.60	43.50	42.30
1980	42.00	39.30	38.60	38.40	37.90	37.60						

Note: See Nuexco Report 135 for a discussion of the definition of Transaction Value.

STATISTICAL DATA

EXCHANGE VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES*

Country	per lb U_3O_8 in Concentrates	per kg U_3O_8 in Concentrates	per kg U in Concentrates
US (dollar)	31.50	69.44	81.89
France (franc)	129.15	284.73	335.77
FRG (mark)	55.47	122.28	144.21
Japan (yen)	6,830	15,058	17,757
Switzerland (franc)	51.18	112.84	133.07
UK (pound)	13.41	29.57	34.87
Australia (dollar)	27.22	60.03	70.79
Canada (dollar)	36.25	79.93	94.25
Niger, Gabon (CFA)	6,458	14,237	16,789
South Africa (rand)	24.31	53.60	63.22

*Calculated using currency exchange rates published in the Wall Street Journal on the last Friday of the month.

LOAN USE CHARGE RATE—7.0%/year

Definition

The Loan Use Charge Rate is Nuexco's judgment of the annual interest rate at which uranium loans could be concluded as of the last day of the month.

Derivation

Nuexco bases the Loan Use Charge Rate upon:

A. Data from recently completed or pending loan transactions.
B. Rates included in firm proposals to borrow or lend.
C. Rates that potential borrowers and lenders have expressed a willingness to pay or accept, but for which Nuexco is not aware of firm proposals.

STATISTICAL DATA

CURRENT TRANSACTIONS*

Nuexco Reference Number	Delivery Period	Approximate Quantity (thousands of pounds, U_3O_8 equivalent)	Approximate Price as percent of Current E.V.	Seller Group	Buyer Group	Remarks
1140	80	50 to 100	–	Europe	Europe	Loan; return in 83.
1144	80	Less than 50	113	US	US	UF_6
1145	80	100 to 300	100	US	US	
1147	80	Less than 50	–	US	Canada	Enriched UF_6; definitive price information not available
1148	80	Less than 50	100	US	US	

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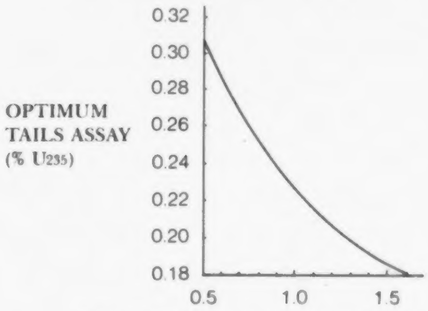
*Transactions listed include not only those in which Nuexco was involved, but also all others of which Nuexco is aware.

STATISTICAL DATA

OPTIMUM TAILS ASSAY

The optimum tails assay is the tails composition at which the cost of enriched uranium is lowest for given costs of separative work (SWU) and natural uranium feed. It depends only on the ratio of the cost of a kilogram of natural uranium in the form of UF$_6$ to the cost of a kilogram unit of separative work. The US Department of Energy (USDOE) Adjustable Fixed Commitment (AFC) enrichment contract holders have the option, within limits, to specify the transaction tails assay. The transaction tails assay for USDOE Requirements contracts is 0.2 percent U$_{235}$. For every one-hundredth of one percent increase in the transaction tails assay, uranium consumption increases about two percent.

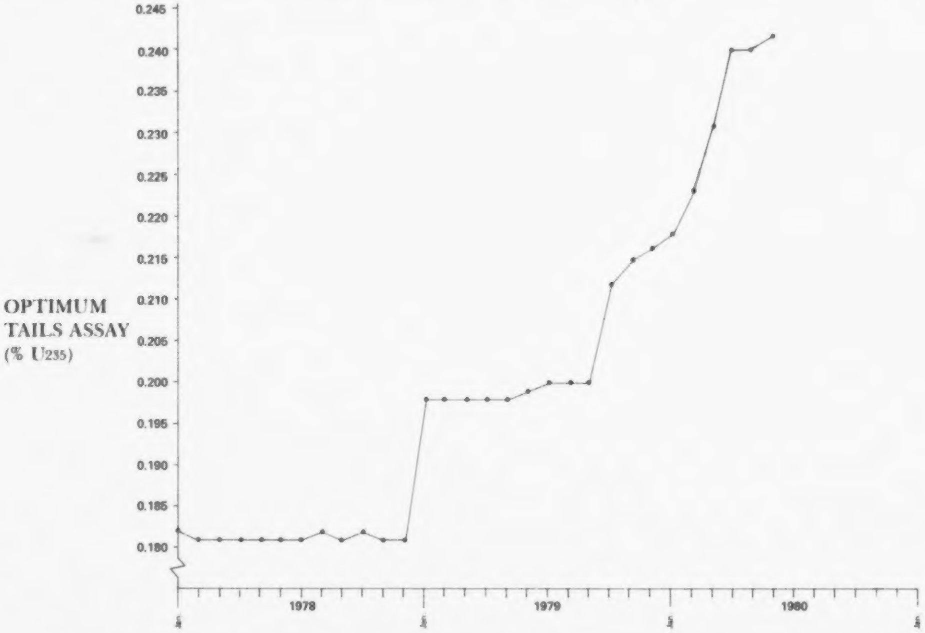
TAILS ASSAY FOR MINIMUM COST OF PRODUCT*



Ratio of Unit Cost of Feed to Unit Cost of SWU

*From Nuexco Report 138

HISTORICAL OPTIMUM TAILS ASSAY[1]



[1] Based on Exchange Value and USDOE AFC SWU price; interpolated to the nearest thousandth.

STATISTICAL DATA

US GOVERNMENT STATISTICS

	Producer Price Index—Industrial Commodities (1967 = 199)[1]	Consumer Price Index (1967 = 100)[2]	GNP Implicit Price Deflator (1972 = 100)[3]	Gross Average Hourly Earnings of Production or Non-supervisory Workers (US$)[4]		
				Metal Mining (SIC 10)	Primary Non-ferrous Metals (SIC 333)	Chemicals and Allied Products (SIC 28)
Annual Avg. 1970 (5)	110.0	116.3	91.36	3.88	3.87	3.69
Annual Avg. 1971 (5)	114.1	121.3	96.02	4.12	4.15	3.97
Annual Avg. 1972 (5)	117.9	125.3	100.00	4.56	4.59	4.26
Annual Avg. 1973 (5)	125.9	133.1	105.80	4.84	4.98	4.51
Annual Avg. 1974 (5)	153.8	147.7	116.02	5.44	5.63	4.88
Annual Avg. 1975 (5)	171.5	161.2	127.15	6.13	6.24	5.39
Annual Avg. 1976 (5)	182.4	170.5	133.71	6.76	6.87	5.91
Annual Avg. 1977 (5)	195.1	181.5	141.70	7.28	7.67	6.43
Annual Avg. 1978 (5)	209.4	195.4	152.05	8.23	8.56	7.01
Annual Avg. 1979	236.3P	217.4	165.46	9.27	9.50	7.59
Mar 1979	225.4	209.1	160.22	8.84	9.11	7.36
Apr 1979	229.0	211.5	–	9.03	9.49	7.50
May 1979	231.6	214.1	–	9.06	9.15	7.47
Jun 1979	234.0	216.6	163.81	9.09	9.44	7.53
Jul 1979	237.5	218.9	–	9.32	9.57	7.60
Aug 1979	240.6	221.1	–	9.38	9.70	7.65
Sep 1979	244.2	223.4	167.20	9.63	9.79	7.73
Oct 1979	249.0	225.4	–	9.67	9.87	7.82
Nov 1979	250.6R	227.5	–	9.79	9.86	7.87
Dec 1979	253.1	229.9	170.58	9.80	9.92	7.91
Jan 1980	260.3	233.2	–	9.92	10.06	7.96
Feb 1980	265.4	236.4	–	9.93	10.01	7.99
Mar 1980	268.2	239.8	174.51	9.91	10.23	8.04
Apr 1980	270.7	242.5	–	10.04P	10.31P	8.11P
May 1980	271.2P	–	–	–	–	8.15P

P = Preliminary R = Revised since last month

(1) US Bureau of Labor Statistics, Washington, D.C.; "Producer Prices and Price Indexes," Table 6 (formerly "Wholesale Prices and Price Indexes"). Producer Price Indexes are revised four months after they are first released to reflect the availability of late reports and corrections by respondents.

(2) US Bureau of Labor Statistics, Washington, D.C.; Consumer Price Index for All Urban Consumers, US City Average, All Items.

(3) US Department of Commerce, Washington, D.C.; Bureau of Economic Analysis, National Income and Wealth Division; "Survey of Current Business," Table A. The GNP Implicit Price Deflator is published quarterly, and seasonally adjusted.

(4) US Bureau of Labor Statistics, Washington, D.C.; "Employment and Earnings," Table C-2. All data based on 1972 revision of SIC Manual. Data for 1970-1976 are adjusted to the March 1977 benchmark. All data for 1977 and beyond are adjusted to the most recent benchmark—March 1978—and are subject to revision from that point forward, with the advent of the next benchmark scheduled for publication in late 1980.

(5) Data for 1970-1978, monthly except for the GNP Implicit Price Deflator, appear on pages 4.6 through 4.8 of Nuexco Report 139.

AUSTRALIAN GOVERNMENT STATISTICS

	Price Index of Materials Used in Manufacturing Industry—All Groups (Year 1968-69 = 100.0)[1]	Weighted Average Minimum Weekly Wage Rates—Adult Males Australia Mining and Quarrying (A$)[2]
Annual Avg. 1970 (3)	101.4	59.88
Annual Avg. 1971 (3)	101.5	65.95
Annual Avg. 1972 (3)	105.6	71.26
Annual Avg. 1973 (3)	124.4	78.96
Annual Avg. 1974 (3)	141.9	108.07
Annual Avg. 1975 (3)	150.4	132.55
Annual Avg. 1976 (3)	168.4	160.93
Annual Avg. 1977 (3)	192.0	179.03
Annual Avg. 1978 (3)	215.4	190.04
Annual Avg. 1979	248.5	196.34
Jan 1979	246.3	189.97R
Feb 1979	253.0	190.19R
Mar 1979	264.0	191.64R
Apr 1979	273.0	192.46R
May 1979	287.5	193.56R
Jun 1979	293.8	196.64R
Jul 1979	295.8	199.22R
Aug 1979	290.8	200.29R
Sep 1979	300.0	201.07R
Oct 1979	307.0	200.53R
Nov 1979	308.0	199.84R
Dec 1979	317.0	200.65R
Jan 1980	337.7	214.77
Feb 1980	343.2P	214.23
Mar 1980	337.9P	213.68

P = Preliminary R = Revised since last month

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(1) Australian Bureau of Statistics, Canberra; "Price Index of Materials Used in Manufacturing Industry" (Catalogue No. 6411.0), Table 3.

(2) Australian Bureau of Statistics, Canberra; "Wage Rates, Australia" (Catalogue No. 6312.0), Table 1. Figures for the latest twelve months shown are subject to revision.

(3) Monthly data for 1970 through 1978 appear on pages 4.7 and 4.8 of Nuexco Report 138.

STATISTICAL DATA

CANADIAN GOVERNMENT STATISTICS

	Industry Selling Price Index: Manufacturing (D 500000)[1,2] (1971 = 100.0)	Wage-earner Data: Average Hourly Earnings (C$)[3,4]		
		Metal Mining, including milling (SIC 050-059)	Primary Metal Industries, non-ferrous (SIC 296-298)	Chemicals and Chemical Products (SIC 370-379)
Annual Avg. 1977	174.3	8.18	6.50	6.51
Annual Avg. 1978	190.4	8.76	6.82	6.97
Annual Avg. 1979	217.9R	9.60	7.35	7.67
Feb 1979	208.5	9.24	7.18	7.36
Mar 1979	210.4	9.47	7.20	7.51
Apr 1979	212.8	9.68	7.26	7.63
May 1979	214.5	9.65	7.28	7.61
Jun 1979	216.0	9.49	7.27	7.66
Jul 1979	218.3	9.37	7.34	7.73
Aug 1979	220.0	9.56	7.38	7.77
Sep 1979	223.4	9.75	7.50	7.81
Oct 1979	227.4	9.89	7.54	7.88
Nov 1979	228.1	9.97	7.61	7.91
Dec 1979	230.4R	9.93	7.51	7.89
Jan 1980	238.8R	9.96	7.57	7.99
Feb 1980	240.6R	10.11P	7.69P	8.08P
Mar 1980	239.0	10.31P	7.83P	8.27P
Apr 1980	240.3P	—	—	—

P = Preliminary R = Revised since last month

(1) Statistics Canada, Prices Division, Ottawa; "Industry Price Indexes" (Catalogue 62-011), Table 1. Indexes for the most recent six months shown are subject to revision.

(2) Monthly data for 1973 through 1978 appear on page 4.10 of Nuexco Report 138.

(3) Statistics Canada, Labour Division, Employment and Payrolls Section, Ottawa; "Employment, Earnings and Hours" (Catalogue 72-002), Table 2.

(4) Monthly data for 1977 and 1978 appear on page 4.11 of Nuexco Report 138.

REPUBLIC OF SOUTH AFRICA STATISTICS

	Average Declared Working Costs per Metric Ton of Gold Ore Milled (Rand)[1]	Consumer Price Index[2] (1975 = 100, except where otherwise indicated)
Annual Avg. 1970 (3)	7.34	100.3 (4)
Annual Avg. 1971 (3)	7.88	106.4 (4)
Annual Avg. 1972 (3)	8.79	113.3 (4)
Annual Avg. 1973 (3)	10.51	124.1 (4)
Annual Avg. 1974 (3)	13.18	138.5 (4)
Annual Avg. 1975 (3)	16.71	157.2 (4)
Annual Avg. 1976 (3)	19.30	174.7 (4)
Annual Avg. 1977 (3)	23.87	194.4 (4)
Annual Avg. 1978 (3)	27.14	137.2
Annual Avg. 1979 (3)	30.18	155.3
Mar 1979	28.60	148.6
Apr 1979	–	149.9
May 1979	–	150.6
Jun 1979	29.44	152.4
Jul 1979	–	157.9
Aug 1979	–	160.2
Sep 1979	30.71	162.1
Oct 1979	–	162.9
Nov 1979	–	163.4
Dec 1979	31.89	164.0
Jan 1980	–	165.4
Feb 1980	–	167.0
Mar 1980	33.65	168.0
Apr 1980	–	170.0
May 1980	–	171.9

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(1) Chamber of Mines of South Africa, Johannesburg; "Analysis of Working Results," published quarterly.
(2) Republic of South Africa Department of Statistics, Pretoria; "Government Gazette: Consumer Price Index for Urban Areas."
(3) Historical data for 1970 through 1979 appear on page 4.9 of Nuexco Report 140.
(4) April 1970 = 100.00

MARKET OPPORTUNITIES

Market Opportunities are *active* inquiries in the uranium market to buy, sell, borrow or lend. The data presented in this section are in no way intended to be indicative of the entire uranium market for the time period covered.

URANIUM SUPPLY

Nuexco Reference Number	Delivery Period (Thousands of Pounds U_3O_8) 1980	1981	1982	1983	Remarks
Available for Sale:					
1213	700				
1236			150	150	
1274	150				
1284	250				
1286	350	150	150	150	
1306		100	200	200	
1315			200	200	
1325	750				
1338	250				
1346	100				
1377	50				
1392	300				
1394	250				
1403	150				
1417	800				UF_6
TOTALS	4100	250	700	700	
Available for Loan:					
1175	700				UF_6
1234	700				
1354	600				UF_6
1355	600				
1429	500				
TOTAL	3100				

MARKET OPPORTUNITIES

Market Opportunities are *active* inquiries in the uranium market to buy, sell, borrow or lend. The data presented in this section are in no way intended to be indicative of the entire uranium market for the time period covered.

URANIUM DEMAND

Nuexco Reference Number	Delivery Period (Thousands of Pounds U_3O_8)				Remarks
	1980	1981	1982	1983	
Inquiries to Purchase:					
1146		100	200	200	
1335	300				
1357		300			
1396	200				
1406	50				UF_6
1408	150				
1410		2000	2000	2000	
1437		70			
1444	50				
TOTALS	750	2470	2200	2200	
Inquiries to Borrow:					
1220	1000				
1348	350				
1415	600				
TOTAL	1950				

MARKET OPPORTUNITIES

Market Opportunities are *active* inquiries in the secondary market for UF_6 conversion services. The data presented in this section are in no way intended to be indicative of the entire market for the time period covered.

CONVERSION SUPPLY

Nuexco Reference Number	Delivery Period (Thousands of Pounds U as UF_6)				Remarks
	1980	1981	1982	1983	
P-1282	250	250			
P-1424	1000				
P-1449		750			
P-1450	750				
P-1451	175				
TOTALS	2175	1000			

CONVERSION DEMAND

Nuexco Reference Number	Delivery Period (Thousands of Pounds U as UF_6)				Remarks
	1980	1981	1982	1983	
P-1424-A	190				

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NUEXCO

AUGUST 1980 NUMBER 144

Monthly Report on the Uranium Market

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EXECUTIVE SUMMARY & INDUSTRY OVERVIEW
NUEXCO REPORT 144

The **Exchange Value** remained at $31.50 per pound U_3O_8. Several Transactions closed this month at prices consistent with the Exchange Value, and other potential transactions are in the final stages of negotiation. More than three million pounds U_3O_8 remain available for sale this year. While the sellers of much of this material are holding out for prices considerably higher than Exchange Value, some sellers remain willing to do business at current price levels. Inventory holders remain a force in the market; about seventy percent of material available for 1980 delivery is being offered by inventory holders.

Nuexco has recalculated its estimates of **Apparent Future Consumption**, and the results are presented in this Report. There was little near term change outside of the **US**. However consumption (defined as uranium entering the enrichment-fabrication pipeline) in the US decreased substantially as a result of the continued licensing logjam at the USNRC. Cumulative US consumption through 1990 decreased by more than 50 million pounds U_3O_8 from the last Nuexco estimate, published only four months ago. More than 80 percent of the decrease is in the years 1980 through 1983. Consumption during 1980 for US reactors under construction dropped to essentially zero. The new estimates of US consumption through 1984 are tabulated below, along with Nuexco's estimate of US production, both in millions of pounds U_3O_8:

	1980	*1981*	*1982*	*1983*	*1984*
Consumption	18	25	30	35	40
Production	36	35	35	33	30

On a worldwide level, the supply excess is more severe. Worldwide production is estimated to exceed consumption by an average of 35 million pounds per year during the years 1980 through 1984.

The first long term contract between a US utility and the new wave of **Australian** producers was announced this month. American Electric Power Company and the Ranger partners signed an agreement covering 4.5 million pounds U_3O_8 for delivery from 1982 through 1990.

The chairman of **South Africa's** Anglo American group stated that important quantities of uranium would probably be stockpiled by South African gold-uranium producers over the next five years. The apparent objective is to avoid putting additional downward pressure on the market.

The make versus buy option is treated in this month's *Topical Essay*, as it relates to uranium producers. Due to the current relationship between spot uranium prices and variable production costs, it appears that many US uranium producers would be considering purchasing uranium to deliver under pre-existing contracts.

This month's *Raw Materials* section covers the uranium industry in the Republic of Niger.

This Executive Summary may be reproduced for internal distribution.

8/80

NUEXCO

MONTHLY REPORT ON THE URANIUM MARKET

August 1980 No. 144

JAMES E. VAUGHAN *EDITOR*

FOREWORD ii

THE URANIUM MARKET
- GENERAL 1
  - Estimate of Apparent Future Consumption 1
- AFRICA 3
- AUSTRALIA 3
- FAR EAST 6
- UNITED STATES 6
- TRANSACTIONS 7
- PRICING 8

TOPICAL ESSAY
- PRODUCE OR PROCURE: THE URANIUM VERSION OF MAKE VERSUS BUY 10

COMMENTARY
- COLLOQUIUM ON CONTINGENCY PLANNING FOR AN ENERGY EMERGENCY 13

RAW MATERIALS
- URANIUM PROVINCE OF NIGER 15

STATISTICAL DATA
- EXCHANGE AND TRANSACTION VALUES 21
- LOAN USE CHARGE RATE 24
- CURRENT TRANSACTIONS 25
- OPTIMUM TAILS ASSAY 26
- GOVERNMENT STATISTICS 27

MARKET OPPORTUNITIES
- URANIUM SUPPLY 31
  - Available for Sale
  - Available for Loan
- URANIUM DEMAND 32
  - Inquiries to Purchase
  - Inquiries to Borrow
- CONVERSION SUPPLY AND DEMAND 33

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FOREWORD

There were two typographical errors in last month's Report, Number 143. In the discussion of Transaction Value in the left-hand column of page 7, it was observed at the bottom of the page that if the Transaction Value was calculated using only the data for the past four months, thus dropping transactions reported in March, the Transaction Value would have been $30.70 per pound U_3O_8. This was in error; the correct figure is $33.70.

The second error was on page 5 under the discussion of Korea. The startup date for Wolsung 1 was incorrectly stated as April, 1980. It should have read April, 1983.

URANIUM MARKET

GENERAL

Estimates of Apparent Future Consumption

In Nuexco Report 140 (April 1980) Nuexco presented revised estimates of Apparent Future Consumption of U_3O_8. Subsequent events warrant revising those estimates once again. Table 1 below contains Nuexco's estimates of Apparent Future Consumption as of July 31, 1980. (The term consumption as used by Nuexco refers to U_3O_8 entering the enrichment-fabrication pipeline.) The corresponding installed nuclear electric generating capacities are shown in Table 2.

US. Nuexco Report 140 contained the following paragraph:

> *The US has undergone some dramatic changes in the past eight months. Reaction to the accident at Three Mile Island, regulatory problems, double-digit inflation, soaring interest rates, and reduced projections of utility load growth have contributed to numerous cancellations, deferrals or delays of nuclear power plants. Although Nuexco's current estimates represent a cumulative reduction (since the last Nuexco estimate, July 31, 1979) of more than 50 million pounds U_3O_8 in US consumption through 1990,* further reductions can still be expected.

Although it was anticipated, this reduction in estimated US uranium consumption has occurred faster and to a greater extent than expected. Of 93 US reactors designated by Nuexco as under construction or on order as of July 31, 1980, 71 have undergone schedule delays during the four month period since March 31, 1980, when Nuexco's previous estimate was published. The weighted average delay in dates of commercial operation, as estimated by Nuexco, for all US plants under construction or on order is more than 22 months.

Table 3 contains a comparison between the Apparent Future Consumption estimates published in Nuexco Report 140 and that published in this Report, for US plants under construction and on order. The cumulative reduction through 1990 is more than 50 million pounds. More than 80 percent of the reduction is in the years 1980 through 1983.

The maximum anticipated annual level of US consumption during the 1980's is only slightly lower than in the previous estimate. Table 1 indicates a maximum US consumption level of about 49 million pounds U_3O_8 per year, attained in 1988. However the anticipated consumption level for 1980 is 10.2 million pounds U_3O_8 lower than the previous estimate. This reduction is almost solely attributable to the licensing moratorium by the US Nuclear Regulatory Commission in the wake of the Three Mile Island accident. The moratorium has been officially terminated, but as of this writing there still have been no new licenses in the US for power operation and few, if any, are expected in the near future. The result is a very large decrease in near term estimated consumption for US plants under construction. The same explanation holds for the large reductions in estimated consumption in the years 1981 through 1983. This development was foreshadowed in Nuexco Report 140:

> *. . . Under current conditions in the NRC, it is likely that no more than six to eight US reactors can be licensed in a given year. Therefore about half of the anticipated 1980 startups will very likely be delayed to 1981. Likewise, many anticipated 1981 startups will be delayed to 1982, 1982 startups to 1983 or 1984, and so on. Under this scenario, additional startup delays of forty reactor-years or more are likely . . .*

Nuexco's current estimate is that total startup delays will be more than 150 reactor-years from the estimate of only four months ago! The delays which have led to the current reduction in estimated consumption will almost certainly serve to further exacerbate the imbalance in the uranium market, which has been discussed in detail in recent Nuexco Reports.

Europe. Nuexco's current estimate of Apparent Future Consumption for Europe represents a cumulative increase through 1990 of approximately 19 million pounds U_3O_8 since the estimate of Report 140. Some of this increase is attributable to new orders; the rest to accelerated construction schedules. There have been several reactor construction starts, and some new reactors have been placed on order.

Far East. Nuexco's current estimate of Apparent Future Consumption is not significantly different from the estimate of Report 140 in their annual totals. However, a substantial shift has taken place as several reactors formerly designated as on order are now under construction.

Methodology. In order to facilitate interpretation of the results presented, the methodology used in developing the concept of Apparent Future Con-

URANIUM MARKET

Table 1
APPARENT FUTURE CONSUMPTION[1]
(millions of pounds U_3O_8)

BUYER GROUP	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
United States												
Reactors Now Operational	16.5	17.4	17.4	17.1	18.0	18.0	18.1	17.4	17.6	18.3	18.2	17.7
Now under Construction	8.2	0.7	7.5	12.8	17.2	22.2	25.4	30.0	27.1	30.3	27.2	27.6
Now on Order	0	0	0	0	0	0	0	0.9	0.3	0.3	3.4	2.0
US Subtotal	24.7	18.1	24.9	29.9	35.2	40.2	43.5	48.3	45.0	48.9	48.8	47.3
Europe												
Reactors Now Operational	12.8	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6
Now under Construction	22.0	14.6	22.5	22.6	21.7	21.1	21.5	21.8	21.1	21.1	21.1	21.1
Now on Order	0	0	0	0.9	4.1	6.0	11.6	7.9	11.8	8.7	9.7	9.7
European Subtotal	34.8	29.2	37.1	38.1	40.4	41.7	47.7	44.3	47.5	44.4	45.4	45.4
Far East[2]												
Reactors Now Operational	4.6	4.6	4.6	4.6	4.6	4.7	4.7	4.7	4.7	4.7	4.7	4.7
Now under Construction	1.5	2.8	3.1	6.8	7.8	6.1	7.9	6.4	6.7	6.7	6.7	6.7
Now on Order	0	0	0	0	0	0	3.3	1.0	1.0	1.4	1.4	1.4
Far East Subtotal	6.1	7.4	7.7	11.4	12.4	10.8	15.9	12.1	12.4	12.8	12.8	12.8
Other Free World[3]												
Reactors Now Operational	2.3	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
Now under Construction	0.7	0.8	2.2	3.7	3.7	3.8	3.8	5.0	4.5	4.5	4.5	4.5
Now on Order	0	0	0	0	0	1.5	0.3	0.6	2.1	1.3	1.3	1.9
Other Subtotal	3.0	3.0	4.4	5.9	5.9	7.5	6.3	7.8	8.8	8.0	8.0	8.6
FREE WORLD[3] TOTAL	68.6	57.7	74.1	85.3	93.9	100.2	113.4	112.5	113.7	114.1	115.0	114.1
WORLDWIDE BREAKDOWN BY STATUS:												
Reactors Now Operational	36.2	38.8	38.8	38.5	39.4	39.5	39.6	38.9	39.1	39.8	39.7	39.2
Now under Construction	32.4	18.9	35.3	45.9	50.4	53.2	58.6	63.2	59.4	62.6	59.5	59.9
Now on Order	0	0	0	0.9	4.1	7.5	15.2	10.4	15.2	11.7	15.8	15.0

[1] Computed quantities of U_3O_8 which would be used under the given conditions, to fabricate fuel for loading and reloading reactors operating, under construction or on order as of July 31, 1980. Compiled and computed on a reactor-by-reactor basis, quantities for each reactor are based on specific core characteristics, 0.20% tails assay, no recycling, 24-month lead time for procuring first cores and 18-month lead time for procuring each reload. Where reload schedule is not already known, these estimates assume reloads occur one year after commercial operating date and annually thereafter. 1979 figures reflect actual capacity factor achieved by each reactor. Estimates for 1980-1990 use Nuexco estimates of individual reactor capacity factors.

[2] Japan, Korea, Taiwan.

[3] Excludes Bulgaria, Czechoslovakia, German Democratic Republic, Finland (2 Russian reactors), Hungary, Poland, Romania, USSR.

Table 2

NUCLEAR ELECTRIC GENERATING CAPACITY[1] [2]

(thousands of MWe—net)

BUYER GROUP	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
United States												
Reactors now Operational	50.0	50.9	50.9	50.9	50.9	50.9	50.9	50.9	50.9	50.9	50.9	50.9
Now under Construction	0	4.3	7.7	10.4	17.8	30.2	38.4	49.2	60.0	70.3	75.0	79.5
Now on Order	0	0	0	0	0	0	0	0	0	2.3	2.3	4.5
US Subtotal	50.0	55.2	58.6	61.3	68.7	81.1	89.3	100.1	110.9	123.5	128.2	134.9
Europe												
Reactors Now Operational	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3	36.3
Now under Construction	0	7.0	26.1	36.2	48.0	55.9	58.8	59.8	60.8	61.8	61.8	61.8
Now on Order	0	0	0	0	0	0.9	5.6	11.8	20.9	24.7	28.6	28.6
Europe Subtotal	36.3	43.3	62.4	72.5	84.3	93.1	100.7	107.9	118.0	122.8	126.7	126.7
Far East[3]												
Reactors Now Operational	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3
Now under Construction	0	0	1.5	4.0	6.3	11.6	17.2	19.0	21.0	21.0	21.0	21.0
Now on Order	0	0	0	0	0	0	0	0	3.0	3.9	3.9	3.9
Far East Subtotal	16.3	16.3	17.8	20.3	22.6	27.9	33.5	35.3	40.3	41.2	41.2	41.2
Other Free World[4]												
Reactors Now Operational	6.5	6.5	6.5	6.	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5
Now under Construction	0	0.4	1.0	2.5	4.7	8.4	10.3	11.1	11.8	13.1	13.1	13.1
Now on Order	0	0	0	0	0	0	0	0.6	1.2	1.2	3.3	4.2
Other Subtotal	6.5	6.9	7.5	9.0	11.2	14.9	16.8	18.2	19.5	20.8	22.9	23.8
FREE WORLD[4] TOTAL	109.1	121.7	146.3	163.1	186.8	217.0	240.3	261.5	288.7	308.3	319.0	326.6
WORLDWIDE BREAKDOWN BY STATUS												
Reactors Now Operational	109.1	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0	110.0
Now under Construction	0	11.7	36.3	53.1	76.8	106.1	124.7	139.1	153.6	166.2	170.9	175.4
Now on Order	0	0	0	0	0	0.9	5.6	12.4	25.1	32.1	38.1	41.2

[1] Installed as of year end.

[2] Uses Nuexco estimates of commercial operating dates.

[3] Japan, Korea, Taiwan.

[4] Excludes Bulgaria, Czechoslovakia, German Democratic Republic, Finland (2 Russian reactors), Hungary, Poland, Romania, USSR

Table 3

COMPARISON OF NUEXCO ESTIMATES OF US APPARENT FUTURE CONSUMPTION: REPORT 140 (APRIL, 1980) VS. REPORT 144 (AUGUST, 1980)

(millions of pounds U_3O_8)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
US Reactors under Construction											
Report 140[1]	10.9	19.4	22.2	24.3	23.4	22.8	25.0	25.2	25.2	25.0	24.9
Report 144	0.7	7.5	12.8	17.2	22.2	25.4	30.0	27.1	30.3	27.2	27.6
Annual Difference	10.2	11.9	9.4	7.1	1.2	(2.6)	(5.0)	(1.9)	(5.1)	(2.2)	(2.7)
US Reactors on Order											
Report 140[1]	-0-	-0-	-0-	2.0	2.4	4.8	4.4	4.3	5.6	7.8	7.3
Report 144	-0-	-0-	-0-	-0-	-0-	-0-	0.9	0.3	3.4	2.0	2.0
Annual Difference	10.2	11.9	9.4	9.1	3.6	2.2	(1.5)	2.1	0.2	2.2	2.6
Cumulative Difference	10.2	22.1	31.5	40.6	44.2	46.4	44.9	47.0	47.2	49.4	52.0

[1] Estimates for Arkansas Nuclear unit 2 have been removed from this category, since the unit entered commercial operation between the two dates of estimate.

sumption, first published in Nuexco Report 128, and developed further in Reports 132 and 140, is repeated here in condensed form:

1. Estimates of Apparent Future Consumption are not forecasts of uranium demand. Rather, these estimates comprise a portion of uranium demand. As indicators of the amount of uranium needed to fuel the reactors under consideration, these estimates should be regarded as relatively hard demand in the sense that this portion of demand is quite insensitive to uranium prices. Market demand for the assumed pattern of capacity additions can be higher or lower, depending on users' inventory policies.
2. Factors which can cause demand to exceed Apparent Future Consumption are:
   a. Utility buyers plan their procurement strategies to achieve a very high probability of having access to at least enough uranium to meet commitments as they arise;
   b. Accelerated reactor construction schedules can advance the dates of uranium need;
   c. Buyers may elect to purchase uranium in excess of need, simply to enhance security of supply.
   d. Utility obligations to suppliers of fuel cycle services such as conversion, enrichment or fabrication, may require earlier purchase of uranium than a reactor's operating schedule would otherwise indicate.
3. Demand can fall short of Apparent Future Consumption if uranium inventories are reduced in order to fill needs which would otherwise appear as demand.
4. Apparent Future Consumption is based on information available today, subject to frequent revision as the date of consumption draws nearer.
5. Uranium is deemed to have been consumed when it has entered the enrichment-fabrication pipeline for ultimate use in a reactor.
6. Reactor loading was calculated, for each reactor, based on its individual core characteristics. This technique is distinct from the method customarily used in estimating reactor requirements simply as a direct function of installed capacity.
7. The estimates assume that:
   a. U_3O_8 deliveries for first cores predate commercial operation by two years.
   b. First reload occurs 12 months after commercial operating date and annually thereafter.
   c. U_3O_8 delivery for each reload predates refueling outage by 18 months.
8. Using the assumptions listed above, the estimate for a given reactor can be computed as a function

URANIUM MARKET

of assumed capacity factor, tails assay and commercial operating date.

9. Reactors fueled by the USSR are excluded from Nuexco's estimates. Although Soviet bloc reactors account for substantial demand, Soviet participation in uranium trading in the Western market has been negligible and appears likely to remain so.
10. Actual commercial operating dates can vary widely from published dates. Nuexco uses the best information available, much of it from unpublished sources, to prepare its own estimates of operating dates.
11. These estimates make no provision for orders not yet placed. Only the requirements associated with reactors operating, under construction or on order are included. Consequently, none of these estimates can be compared directly to forecasts of uranium requirements. Rather, these estimates should be regarded as minimum requirements.
12. The analysis period of 11 years was chosen as an arbitrary measure of the longest expected time interval between inception and commercial operation of a nuclear power plant.
13. The total of approximately 51,000 MWe (net) in Table 2 under the classification of *Reactors Now Operational* in the US is based on 70 reactors. Shippingport and Hanford were not included. Arkansas Nuclear unit 2 was added to the *Reactors Now Operational* category because it was declared commercial on April 25, 1980. Sequoyah unit 1, North Anna unit 2, and Salem unit 2 were not included because their licenses are for startup testing only. Consumption estimates for these reactors were included under the category of *Reactors Now Under Construction*. Included in the 70 reactors were Indian Point unit 1, Humboldt Bay, and TMI unit 2, even though these plants are indefinitely shut down. Consumption estimates included in Table 1 for the latter three units reflect their non-operational status.

AFRICA

Uranium production in the **Republic of South Africa** totaled 3.98 million pounds U_3O_8 in the second quarter of 1980, an increase of four percent over the first quarter. An expansion of the uranium treatment plant at Western Deep Levels was commissioned during the quarter.

South Africa's largest uranium producer, the Anglo-American group, has indicated in the recently published Chairman's statement that South African producers might stockpile important quantities of U_3O_8 over the next five years. This statement might reflect the possible course of action which some South African producers expect to take with respect to uncommitted production in the near and intermediate term markets. With the price of gold at its current very high level, many gold-uranium producers may be in a position to forego near term income from uranium. The objective apparently is to avoid further depressing the near term market, and to take advantage of possible future upswings.

AUSTRALIA

The long-rumored deal between Ranger and a US utility closed this month as American Electric Power and the Ranger partners, Peko-Wallsend and Electrolytic Zinc, announced the signing of uranium supply contracts covering 4.5 million pounds U_3O_8 over a nine-year period, 1982-1990. Formal approval of the Australian government is required before the contract is binding.

While the terms of the agreement have not been made public they include, presuming the agreement is in accordance with the determinations of the Australian government, floor and market price provisions and extensive safeguards. Based on current market conditions it may be presumed that the floor is at or near the reported Australian minimum of US$30.00. An interesting aspect of the contract relates to its term of nine years, which presumably is designed to moot the Australian enrichment requirement that, after 1990, buyers agree to accept a minimum of 35 percent of scheduled deliveries in the form of enriched product.

The contract was the result of a long negotiation made more difficult by a weakening market, and is the first one between the Northern Territory producers and a US buyer. Its success is particularly important to the overall Australian marketing effort in the US. It is generally conceded that if the Australian government does not approve the contract, Australian hopes of penetrating the US market would receive a severe setback.

In other developments affecting Ranger, the ERA consortium is nearing finalization, although the public stock offering is still believed to be several months off.

FAR EAST

Japan's energy supply structure is among the most fragile of large industrialized nations. Of Japan's primary energy requirements, 90 percent are imported and 75 percent come from imported oil. Since the oil suppliers are concentrated geographically there is limited diversity in transportation routes.

The economic and strategic implications of this situation are of significant and growing concern to Japan's leaders, particularly when, even with an aggressive conservation program, primary energy needs are projected to increase by more than 50 percent by the year 1990.

Thus, by 1990, Japan aims to reduce its reliance on imported oil to no more than 50 percent of its primary energy needs with the balance coming from alternate energy sources, primarily nuclear, coal, LNG, LPG and, to a lesser extent, solar, geothermal, synfuels and the other more exotic sources. Notwithstanding the public attention being given the exotic energy sources, the major investment decisions currently being made demosntrate that Japan is planning to rely on proven technologies, particularly nuclear power and coal.

UNITED STATES

Energy Fuels, Ltd. recently started up its new White Mesa uranium facility near Blanding, Utah. The mill is now running at its rated capacity of 2,000 tons ore per day. Figure 1 is a photograph of the White Mesa mill.

The Energy Information Administration (EIA) of the US Department of Energy has released its latest predictions of US installed nuclear capacity through 1995. These figures are reproduced in Table 4. Also, the EIA has estimated uranium requirements based

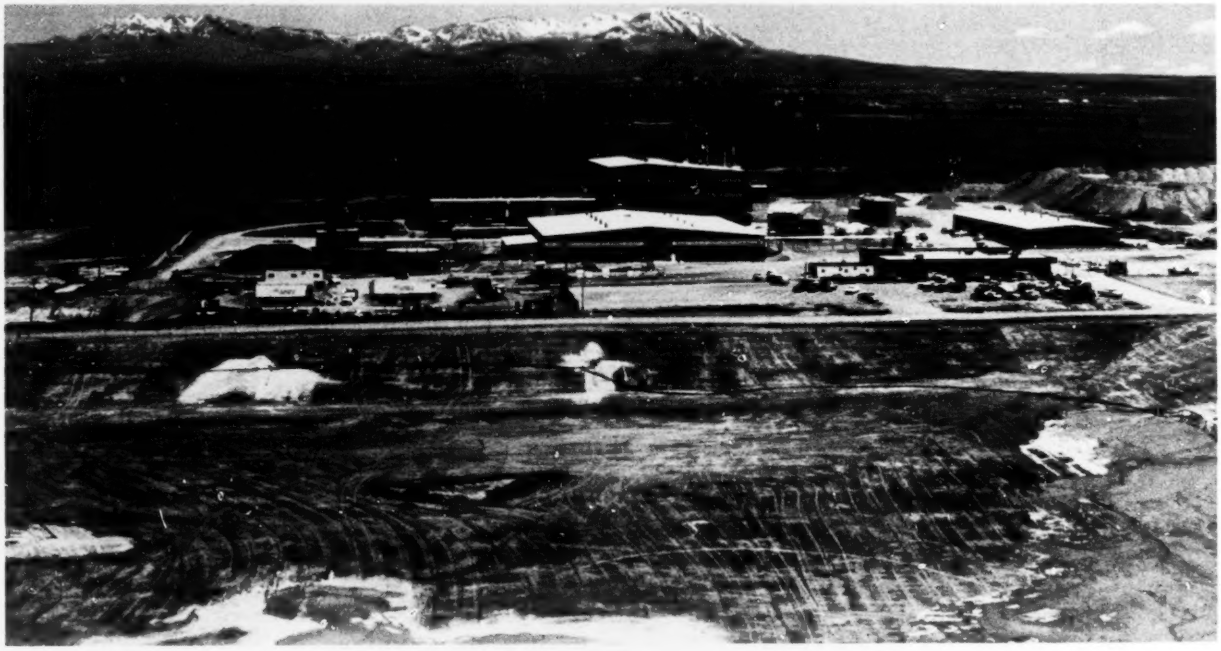

Figure 1
AERIAL VIEW OF THE RECENTLY COMPLETED WHITE MESA URANIUM MILL OF ENERGY FUELS, LTD. NEAR BLANDING, UTAH

on its nuclear power forecast, and these are reproduced in Table 5. The estimates in Table 5 were prepared by EIA at Nuexco's request and were calculated using EIA's usual computational methods. However they do not represent official EIA forecasts of uranium requirements.

Historically, the uranium market has slowed down in mid-summer. This year seems to be an exception. Some of the current activity is by buyers trying to lock in the present price level over longer term contracts. US utilities have made inquiries for intermediate and long term supply contracts for substantial quantities. Non-US origin material is being more seriously considered than in the past, as highlighted by the recently completed agreement between Ranger and American Electric Power.

TRANSACTIONS

Sales: There were six sales transactions concluded this month. One large, long term agreement was made between an Australian producer, the Ranger partners, and a US utility, American Electric Power. A small, short term sale of enriched UF_6 was made from a US utility to a non-US government agency. Another small spot sale occurred between two US producers. A US producer sold between 100,000 and 300,000 pounds U_3O_8 to a European utility for delivery in late 1980. Also, a European utility purchased between 100,000 and 300,000 pounds of U_3O_8 equivalent as UF_6 from a US producer. Finally, a non arms-length transaction was closed between two Canadian producers for 50,000 to 100,000 pounds of U_3O_8.

Loans: Two loans closed this month, both involv-

Table 4

USDOE ENERGY INFORMATION ADMINISTRATION FORECAST[1] OF NUCLEAR GENERATING CAPACITY[2]

(thousands of MWe—net)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995
LOW CASE	53.2	57.4	65.2	73.6	77.3	86.6	96.2	106.7	116.4	121.6	122.9	137.0
MID CASE	55.4	61.7	72.5	79.2	86.6	98.4	111.4	119.6	123.8	125.6	127.8	151.0
HIGH CASE	55.4	68.4	77.1	86.3	99.7	108.9	117.1	124.5	125.6	134.8	139.5	159.9

[1] As of July 31, 1980.

[2] Installed as of end of year.

Table 5

USDOE ENERGY INFORMATION ADMINISTRATION FORECAST[1] OF NATURAL URANIUM REQUIREMENTS[2,3]

(millions of pounds U_3O_8)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1995
LOW CASE	29.0	29.6	30.8	36.2	39.8	43.6	44.6	43.6	46.4	47.8	50.4	53.8
MID CASE	30.0	31.2	36.6	41.0	44.4	46.0	45.8	48.5	51.0	51.6	51.6	61.0
HIGH CASE	30.2	36.9	41.6	44.0	46.1	46.6	50.7	53.2	53.6	55.2	56.4	66.3

[1] As of July 31, 1980.

[2] Based on a capacity factor of 65%, no recycle, and 0.2% tails assay.

[3] These estimates were generated by the Energy Information Administration at Nuexco's request. Although based on the nuclear power forecasts published in EIA's *Annual Report to Congress, 1979*, they do not represent official EIA forecasts of uranium requirements.

ing between 100,000 and 300,000 pounds U_3O_8 equivalent as UF_6. In each case the lender was a US utility, while the borrower was a US producer. One of the loans commences immediately; the other is to start in early 1981. The loans are scheduled to be returned in 1983. The interest rate in both cases is consistent with the Nuexco **Loan Use Charge Rate.**

PRICING

The **Exchange Value** held at $31.50 per pound U_3O_8. Selling pressure eased somewhat this month due to the completion or near-completion of several transactions. However, demand for 1980 delivery is now virtually absent. Inquiries to sell material for 1980 delivery involve a total of 3.3 million pounds U_3O_8 equivalent, but inquiries to buy for 1980 delivery amounts to only 225,000 pounds U_3O_8. (See *Market Opportunities* section.)

Approximately 70 percent of the material currently available for sale in the near term market is being offered by inventory holders. Sellers of a large percentage of the 3.3 million pounds available for 1980 delivery continue to hold out for prices well above current Exchange Value. However, there are still several sellers willing to sell at around Exchange Value. Several potential transactions for near term delivery have entered the final stages of negotiation and are expected to close within the next few weeks.

The market weakness which precipitated the rapid decline in price can be expected to continue for some time. Continuing delays in starting up new reactors in the US has resulted in an even further decline in near term uranium usage. Table 6 compares uranium production with consumption in the US. The prolonged drought of new US reactor startups has reduced Nuexco's estimate of uranium consumption in 1980 for plants under construction almost to zero. Thus uranium production in the US in 1980 is expected to be about twice consumption. The licensing logjam will probably continue. Even though US production is expected to decline, US consumption will probably not equal US production until 1983.

The worldwide production and consumption picture is presented in Table 7. Production is expected to exceed consumption by an average of 35 million pounds per year during the years 1980 through 1984. These conditions suggest the continuation of a relatively strong buyers' market for some time.

Table 6
US URANIUM PRODUCTION AND CONSUMPTION
(millions of pounds U_3O_8)

Year	Production[1]	Consumption[2]
1980	36	18
1981	35	25
1982	35	30
1983	33	35
1984	30	40

[1] Nuexco Report 141, rounded to nearest million.
[2] This Report, Table 1, rounded to nearest million.

Table 7
WORLD[1] URANIUM PRODUCTION AND CONSUMPTION
(millions of pounds U_3O_8)

Year	Production[2]	Consumption[3]
1980	105	58
1981	116	74
1982	120	85
1983	124	94
1984	127	100

[1] Including the US, but not including Communist areas.
[2] Nuexco Report 141, rounded to nearest million.
[3] This Report, Table 1, rounded to nearest million.

The **Transaction Value** once again declined only slightly to $37.30 per pound U_3O_8. The Transaction Value continues to be dominated by transactions which closed several months ago. This month's sample extends over six months and includes 19 transactions involving a total of 4.3 million pounds U_3O_8. Eight of those transactions, accounting for 3.1 million pounds U_3O_8, closed in February 1980. At that time spot prices were considerably higher than today.

In the current thin market, the requirement to include at least two million pounds U_3O_8 in the sample is quite restrictive. Under the present definition of Transaction Value, the February transactions must

URANIUM MARKET

remain in the sample until another 800,000 pounds U_3O_8 have been sold under conditions which meet the tests for inclusion in the sample. (See definition of Transaction Value in *Statistical Data* Section.)

If the requirement for a minimum sample size of two million pounds were halved, the current Transaction Value would be $33.40 per pound U_3O_8. The corresponding figure for last month would have been $33.70 (incorrectly reported last month as $30.70 due to a typographical error).

A divergence between the Exchange Value and the Transaction Value is the expected response to a sudden price change, either upward or downward, in a thin market. The degree of divergence indicates the degree to which the market has changed in recent months.

The secondary market for **conversion** services is relatively quiet. One small transaction is in the final stages of completion at a price in the range of $1.50 per pound U as UF_6. Other transactions for conversion services can probably be completed for near term delivery at about the same price. The secondary conversion market is described in Nuexco Reports 138 and 143.

TOPICAL ESSAY

PRODUCE OR PROCURE: THE URANIUM VERSION OF MAKE VERSUS BUY

One of the classic problems that confront a manufacturing manager is deciding whether to make a part in-house or to buy it from outside sources. For example, an automobile manufacturer must decide whether to make the nuts and bolts used to assemble the car, or to purchase them from an outside supplier. The recent decline in the spot market price of uranium has resulted in the uranium industry's own version of this traditional make versus buy problem. More specifically, high cost uranium producers with existing supply contracts may be in a position to determine whether they will fill their contracts with their own production or with material purchased on the spot market.

In making this choice of producing versus procuring, the decision would ideally be reduced to two comparative costs from which the cheapest option for the company would be chosen. Unfortunately, in practice, this is usually not the case. The decision is complex, and consists of at least two considerations: (a) the quantitative, deriving the economic comparison of the two options, and (b) the qualitative, which consists of all the intangible factors that go into such a decision.

In determining the quantitative difference between producing versus procuring, the controlling concept is usually the producer's *variable* cost of production. The variable cost of production is that portion of total cost which is directly related to the incremental production of the material. Total production cost of uranium concentrates, or most other products, is usually thought of as consisting of three components: fixed overhead, variable overhead and direct costs. The combination of variable overhead and direct costs make up the producer's total variable cost of production. Fixed overhead, on the other hand, is the portion of production cost which would be incurred regardless of the quantity of uranium produced. This includes such things as debt service and depreciation of fixed assets.

Variable costs include such things as direct labor involved in mining the uranium, materials and supplies used in mining, such as fuel and electricity, the cost of hauling ore from mine to mill, labor and materials used in operating the mill, some royalties, severance taxes, reclamation costs which are quantity dependent, the variable portion of overhead, and other expenses directly related to incremental production of uranium. Thus in using the variable cost in the make versus buy decision, the uranium producer is comparing the price to purchase with the real savings to be attained if production is cut. From a purely quantitative standpoint, a producer should be inclined to cut production to the extent that its incremental cost of purchasing concentrates to supply existing contracts is less than its incremental variable cost of producing those concentrates.

The cost of the purchasing option may include more than the purchase price of the concentrates, however. If a mine is to be completely shut down, for example, the cost of taking it off line and maintaining it thereafter must be included in the purchase option. In addition, some mining leases require that, if there is no production from the leased property, certain payments must be made to the lessors, or the lease may be terminated. These payments must also be included in the cost of the buy option.

While the quantitative aspect of the make versus buy decision can often be reduced to a single number, or at least a set of numbers, the qualitative aspect is far more difficult to assess. There are numerous intangible factors that must be considered in determining the outcome of the produce versus procure question.

Qualitative factors favoring the continuation of production include

- A slowdown or shutdown of work may mean the loss of skilled labor.
- It is not possible to shut down a wet mine entirely without losing it. If a mine floods, it is a total loss.
- The producer might not have the contractual right to substitute purchased concentrates under its supply contract. That is, the existing supply contract might require production from a certain ore body. However, if the spot market price is substantially below the producer's variable cost of production, the producer might benefit by renegotiating its contract with its customer to allow for substitution of purchased material, with some mechanism provided for sharing of savings between the producer and the customer.
- There may be some difficulty in obtaining suitable concentrates on short notice. This might appear improbable given the large worldwide commercial inventories of uranium. However

TOPICAL ESSAY

these inventories are physically located at UF₆ conversion facilities, for the most part. It may therefore be difficult to transfer material in the form of concentrates to uranium producers wishing to purchase on short notice.

- Some mining leases are subject to forfeiture if there is no production from the leased property.

Qualitative factors promoting the purchase option include:

- Purchasing during a down market would enable a producer to conserve its reserves for a later time when the price might be higher.
- Uncertainties regarding precipitous changes in environmental, health, and safety legislation, and severance taxes would be mitigated by the purchase option.
- The producer's anticipated production rate may be insufficient to meet existing obligations.

These and other qualitative factors will normally go into the make versus buy decision, along with the quantitative factors. The relative effect of these intangible factors will vary in impact and magnitude and many times will be the critical factor that determines whether it is best for the producer to adopt a procurement policy, or to continue producing.

The make versus buy decision will probably not be a one-time decision, but will often be a continuous decision making function. Changes may occur from time to time which will shift the balance. The spot market price of uranium may change, production costs, especially variable costs, change frequently, and the intangible factors are in a constant state of flux.

Figure 2 indicates Nuexco's estimate of the distribution of US variable production costs for uranium. The horizontal axis represents variable production cost, excluding return on investment. The vertical axis represents the percentage of US production capacity with higher variable production cost than the cost indicated at any point on the curve (i.e. Figure 2 is an integral distribution). The cost estimate is as of the first quarter, 1980. The distribution is based on Nuexco's estimate of the *average* variable cost of each US producer.

Figure 3 indicates why the make versus buy decision has now become an important consideration in the uranium market. The Nuexco Exchange Value, since January, 1980, is plotted along with a family of curves representing the higher cost end of the US variable production cost profile. It was assumed that changes in variable production costs will roughly parallel inflation, so the costs plotted in Figure 2 have been escalated at the rate of one percent per month from the first quarter of 1980.

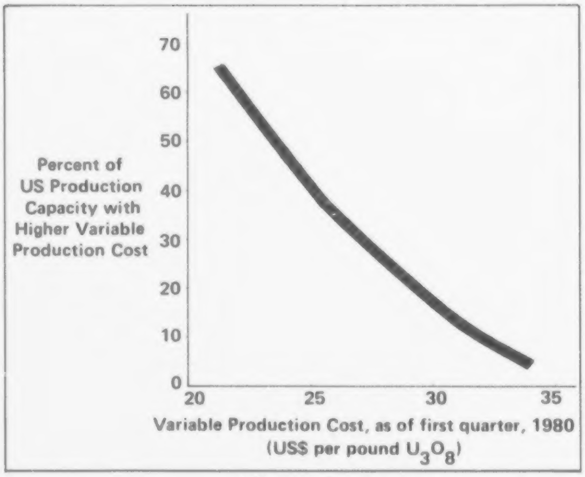

Figure 2

ESTIMATED DISTRIBUTION OF US VARIABLE URANIUM PRODUCTION COST

Figure 3 indicates that six months ago, the procure option may not have been of much interest to US producers, except in those cases where intangible factors may have indicated a buy decision. With the drop in spot prices over the past few months, combined with inflationary increases in variable costs, however, it now appears that producers producing about 25 percent of US uranium would at least be considering the buy option.

Figure 3 oversimplifies the problem somewhat in that it does not treat incidental expenses involved in the buy option, such as the cost of derating existing facilities. More importantly, the cost distribution which appears in Figure 2 and Figure 3 was based on Nuexco's estimate of each US producer's *average* variable cost. Actually, many producers have an internal distribution of production costs, especially those producers with multiple sources of ore. Thus an individual producer whose average variable cost might be below the level at which it would be economically beneficial to purchase rather than produce might still choose to purchase part of its commitments in order to phase out a part of its production capability in which variable costs are very high.

TOPICAL ESSAY

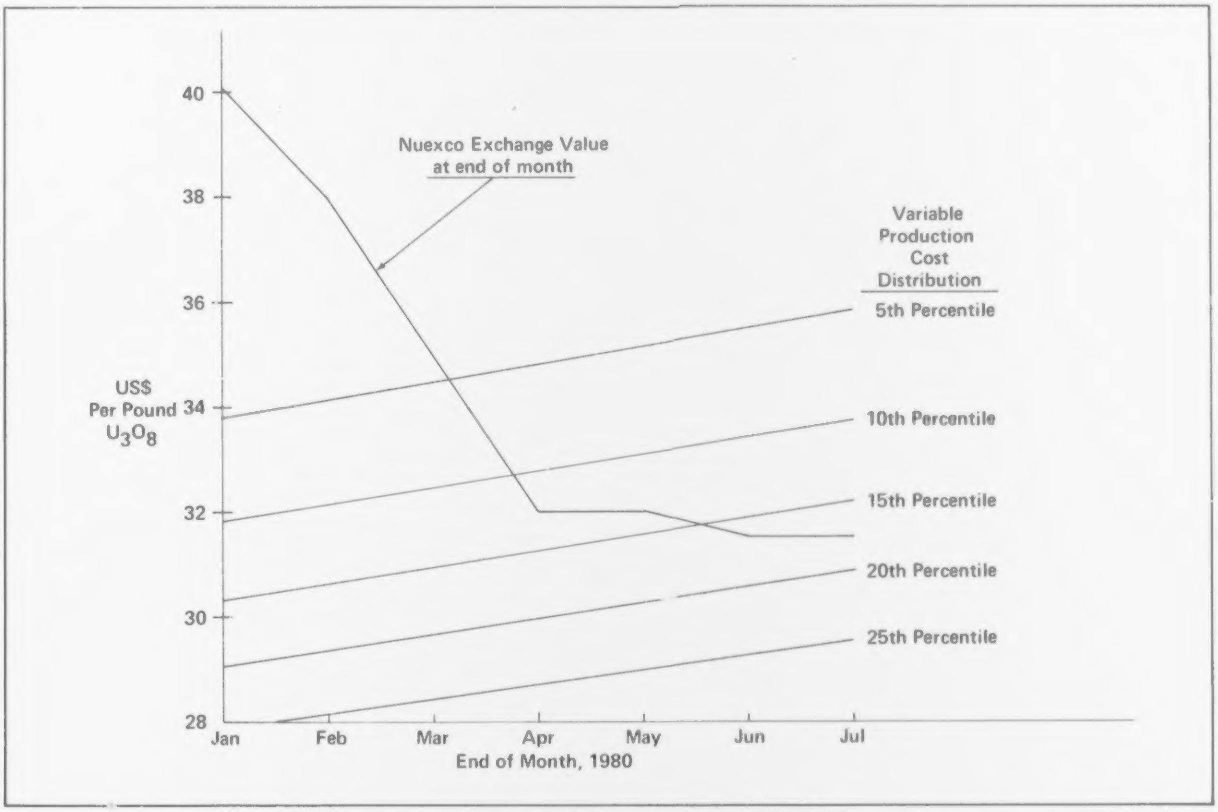

Figure 3

NUEXCO EXCHANGE VALUE COMPARED WITH VARIABLE PRODUCTION COST DISTRIBUTION OF US URANIUM PRODUCTION

COMMENTARY

COLLOQUIUM ON CONTINGENCY PLANNING FOR AN ENERGY EMERGENCY

A meeting was held in June at Stanford University among 60 of the leading academicians and industrialists in the US concerned with energy problems. It was entitled "Contingency Planning for an Energy Emergency" and dealt with examining the consequences of a sudden cutoff of oil from the Persian Gulf.

The colloquium concluded that prolonged interruption of oil supplies from the Gulf by any one of a number of scenarios (e.g. revolution, Soviet expansionism, etc.) is a real possibility. There was nearly unanimous agreement that the economy of the US and its allies would be in jeopardy if this occurred, and that immediate programs to reduce this vulnerability should be instituted.

The colloquium was sponsored by Scientists and Engineers for Secure Energy and by the Hoover Institution of Stanford. The participants considered how the energy requirements of the United States could be met if the contingency occurred. The physical limits of a national response covering a period of five years from the cutoff were investigated. Topics discussed included: emergency conservation measures; possible expansion of oil supplies from alternate sources; substitution, when possible, of gas, coal and electricity for oil; effects on electric power generation; rationing and other forms of allocation; economic effects and changes in life style; and advance preparations to reduce US vulnerability to such an occurrence.

The colloquium findings were as follows: The initial situation faced by the industrial democracies after a complete cutoff (which is a limiting case of more probably partial cutoffs) would be a shortfall of about 45% of their oil supplies, or 16 million barrrels/day. According to the existing oil-sharing agreements between the US and the other members of the International Energy Agency, the shortfall would be distributed thus:

- US oil supply would be reduced about 35%, by six million barrels/day,
- Oil supply of US allies would be reduced about 55%, by 10 million barrels/day.

Specifically, in the US, a cutoff of Mideast oil would:

- cause the transportation system to be greatly disrupted. Private automobile use would be reduced about 50%, and other vehicle transportation would be cut about 30%.
- cause massive additional unemployment of over 8 million workers, and reduce annual disposable income by over $3000 per household
- impair US ability to mobilize effectively defenses.
- lower the Gross National Product by $350-650 billion per year (about 15 to 25%)
- depending on the timing of the cutoff, in some parts of the country the closing off of some housing space could be expected, as well as accelerated movement of people to a warmer climate.
- shopping habits would undergo dramatic changes, and recreational and cultural activities would be greatly curtailed.

In the five years subsequent to an oil cutoff, assuming only present technologies could be effective on a large-scale, replacement of the US oil supply deficit by expansion of domestic and other foreign oil supplies, and by substitution of other fuels, would be substantial but still only partial (40 to 60 percent of shortfall). To avoid the vulnerability of the US to these consequences, the participants of the colloquium recommended a number of measures.

1. The security of the US requires the implementation of an aggressive program to increase both energy production and the more efficient use of oil. The object of this program should be to reduce vulnerability to loss of imported oil as quickly as possible. Examples of opportunities for increased sources of energy supply are: coal, gas, nuclear power, biomass, and on a longer time scale, shale oil. As was proved during World War II, high level policy organization is an absolute prerequisite for organizing and implementing an effective program.

2. Rapid decontrol of oil and gas prices and abolition of entitlements are the most important ways of providing needed incentives to displace oil imports by inducing real conservation and increasing supply. Equity concerns, such as undue burdens on people with low incomes, should be dealt with by transfer payments rather than by manipulating prices or by allocations.

3. Environmental laws should be administered and perhaps amended to encourage energy production as well as to protect the environment.

4. Licensing for operation of completed nuclear plants should be expedited in order that the plants may be put in production immediately. Partially

completed power plants (both coal and nuclear) should be completed on an accelerated schedule. Unnecessary regulatory impediments to other energy facilities (such as pipelines, port facilities and drilling platforms) should be removed.

5. Oil for non-transportation uses should be promptly replaced by natural gas and coal and nuclear generated electricity. Limitations on production and use of natural gas and electricity should be reduced to permit price competition to determine their relative market shares. Electric utility rates should reflect the marginal costs of new power plants.

6. The energy industries should with government encouragement jointly prepare emergency plans against an oil cutoff. Among other measures, acquiring spare production and storage capacity should be encouraged.

7. The automotive industries should be encouraged to increase their efforts to produce more fuel efficient automobiles, including electrical and hybrid vehicles.

8. Contingency plans should be made to curtail energy consumption, and to temporarily suspend some procedural requirements and environmental standards, in the event of an oil cutoff. Wide public discussion of these plans at the community and the factory levels should be inaugurated.

9. In addition to the present US 90-day commercial oil reserve, a Strategic Petroleum Reserve should be accumulated at a rate of more than 300,000 barrels per day. If it were possible to fill it at a rate of one million barrels per day, an amount of oil necessary to supply the economy with six million barrels per day (the maximum projected deficit) for four months would be accumulated in two years.

10. Since the use of oil in Western Europe & Japan for generating electricity is about three million barrels per day, it is in the interest of the US to reduce their vulnerability by encouraging and assisting their conversion to nuclear energy and coal.

URANIUM PROVINCE OF NIGER

Introduction

Uranium was first discovered in the Air region of The Republic of Niger in 1957. During the ensuing years, additional ore discoveries were made and a producing industry developed. The Air region of Niger is presently one of the world's important uranium provinces. Its uranium resources are roughly estimated at 100,000 to 200,000 tonnes U.

The discovery of large stratiform uranium deposits has been limited to the Air region where the geology and mode of uranium occurrence is comparable to the Grants uranium district of New Mexico. The area lies within the depositional transition zone of marine sedimentation from the north and continental sedimentation from the south, and includes local Precambrian highlands. The important uranium mineralization occurs in continental sediments of Carboniferous and Jurassic age. Geologically, the entire north and central areas of Niger are also favorable for uranium occurrences.

Geologic History

The interpretation of the geologic history of Africa led to the identification of potential exploration areas and eventually to uranium discoveries in Niger and elsewhere in Africa. The interpretation still remains valid today, and is used as an aid in the initiation of exploration projects, especially in frontier areas.

Generally, the geology of Africa indicates that the entire continent has remained relatively stable since Precambrian time. However, during Precambrian time, the continent was subjected to major tectonic events of mountain building and the formation of structurally related intracontinental basins. The northern portion of the continent became tilted downward toward the north, probably as the result of regional subsidence and down-warping associated with early movement along the Mediterranean tectonic belt.

Post Precambrian activity saw the beginning of a long period of erosion and fluvial deposition. Subsequently a thick accumulation of stream sediments was deposited in the basin areas throughout the continent. The low area in the north was intermittently invaded by transgressive epicontinental seas, resulting in the deposition of thick marine sediments which spread southward into what is now Niger. Marine deposition continued throughout the Lower Cretaceous Period; continental deposition continued through the late Tertiary.

Sandstone facies of continental sediments throughout Africa are potentially favorable hosts for uranium occurrences. In fact, stratiform accumulations of uranium in sandstone are known to occur in Algeria, Gabon, the Central African Republic, Zambia, South Africa and Niger. Promising indications of mineralization are being evaluated in these countries as well. However, the only stratiform deposits being mined at this time are in Niger and Gabon.

Uranium Geology

Uranium exploration in Niger was initiated by the French Commissariat a l'Energie Atomique (CEA) in the Air region during 1954. Airborne and ground radiometric surveys were successful in the discovery of numerous radioactive anomalies during the following three years. Certain anomalies were evaluated in detail, and drilling for subsurface mineralization was done in some cases. The first significant uranium discovery was made in 1957. The CEA recognized the potential of the Air region and has since concentrated exploration in the Agadez Basin, an isolated structure within the vast Iullemeden Basin. Other exploration groups taking up prospecting permits in Niger have likewise concentrated their interest in the Agadez Basin, although prospecting has spread to other areas within the Iullemeden Basin.

The Iullemeden Basin is bordered to the east and north by Precambrian crystalline rocks of the Air and Hoggar Mountains respectively, by crystalline rocks of the Eburnean highland to the soutwest, the Chad Basin to the east, and the Taodeni Basin to the west. The Iullemeden Basin is filled with fine to coarse clastic, continental sediments interbedded with mudstones, volcanic ash and tuffs. The age of the rocks ranges from Carboniferous to Cretaceous.

The Agadez Basin lies immediately west of the Air Mountains. The principal uranium host formations consist of fluviatile to near-marine sandstones of various geologic age within the sedimentary sequence filling the basin. The uranium deposits at Arlit, Akouta and Madouela occur in Carboniferous rocks, the Azelik deposit in Premian-Triassic rocks, and the Imouraren deposit in Jurassic rocks. In all the deposits, coffinite and pitchblende are the only uranium minerals present.

The formations filling the Agadez Basin dip gently from the Air Mountains. Toward the western part of the basin, the formations are uplifted by the Arlit fault, a major north-south structural feature which bisects the basin. The sediments are further displaced by minor northeast-southwest trending faults. Known ore deposits appear to be related to the faulting. In fact, the major ore deposits are located immediately east and parallel to the Arlit fault. Present exploration activity is therefore concentrated in areas with similar geologic characteristics. There are at least 10 exploration and mining projects in Niger at this time.

Exploration of Agadez Basin

Local interpretation of the basin geology has required the application of sophisticated exploration techniques. Each discovery of mineralization has given rise to new geologic and exploration ideas, all of which were important to the eventual discovery of additional ore deposits. Essentially all exploration techniques developed for the Agadez district are applicable to exploration of continental sediments throughout Africa.

The CEA intensified its exploration activities after the first discovery in 1957. Subsequently, 65 radiometric anomalies were discovered by airborne methods; visible uranium mineralization was noted on 18 of the anomalies. The Azelik structure was identified as a strong anomaly and systematically prospected in 1959, resulting in the discovery of the first important uranium deposit in Niger. Uranium mineralization of primary importance was found in a Carboniferous sandstone on both sides of a secondary northeast trending fault. Uranium of secondary importance was found in channel-filling Cretaceous sandstone, west of the fault.

Table 8 contains a breakdown of participation in the various exploration and mining operations in The Republic of Niger. The Azelik deposit has been through at least two major exploration phases. The CEA core drilled a total of over 14,000 feet before conceding in 1971 that there was insufficient tonnage in the deposit for commercial development. Later, additional drilling resulted in the location of two deposits containing approximately 12,000 tonnes U.

The Madouela deposit was disocvered by the CEA in 1962. Mineralization was found associated with basal paleochannel sands and conglomerates of the Guezouman formation overlying the black shales of the Talak Formation, both Carboniferous in age. The channel was delineated for about five miles down-dip from a northeast-southwest fault. Two separate ore deposits were drilled out—the Marianne and Marylin. Additional evaluation drilling in 1964 was successful in proving ore reserves of about 6,200 tonnes U. Reserves were considered insufficient for profitable mining at that time. The deposits are now included in a new prospecting permit area, referred to as Afasto Est.

The Arlit deposit was discovered by the CEA in 1965. Again, mineralization was found in the basal Guezouman Formation, and in the younger Tarat-Madaouela Formation. Detailed exploration resulted in the discovery of three separate ore deposits with estimated total reserves of 22,000 tonnes U. The Arlette ore deposit was put into production by Somair in 1970, and first mill production began in 1971. The Arlette deposit has since been mined out and the Ariege deposit is now being mined. The Artois deposit is in the early stages of development and will be brought into production as the Ariege deposit is phased out. The predominant uranium mineral in the three deposits is coffinite. The main accessory mineral is pitchblende.

The Akouta deposit was discovered in 1966, also by the CEA, about 10 km south of Arlit. A total of 105 holes were drilled to an average depth of 860 feet during the next three years. Mineralization was discovered in basal channel units of the Tarat and Guezouman formations, as at Arlit. Ore reserves are estimated at 40,000 tonnes U. Coffinite and pitchblende are the predominant uranium minerals present. Underground mining of the Akouta deposit began in early 1978; mill production began in August, 1978 at a rate of 2,000 tonnes ore per day.

The Arni deposit was discovered by the CEA about four km southwest of the Arlit deposits in 1969. Ore reserves have been estimated at 20,000 tonnes U. A project feasibility study was recently completed, and detailed engineering studies are now in progress. It appears that ore can be mined by open pit methods.

The Imouraren deposit was discovered about 80 km south of Arlit by the joint venture of Onarem, Cogema and Conoco in 1967. Ore grade mineralization was found in three different sandstones of Jurassic age. The host rock is channel-filling, coarse sandstone associated with interbedded mudstone. The upper ore zone is at an average depth of 350 feet. The

Table 8

ACTIVE EXPLORATION AND MINING PROJECTS IN THE REPUBLIC OF NIGER

Project Designation	Participants	Percentage Held
1. Azelik	Onarem (Niger)[1]	50%
	IRSA (Japan)	50%
2. Madaouela Afasto-Est	Onarem	30%
	Cogema (France)	30%
	Nigeria	16%
	CEGB (UK)	12%
	Saarberg Interplan (FRG)	12%
3. Arlit (Societe des Mines de l'Aire—Somair)	Onarem	33.0 %
	Cogema	19.96%
	CFMU (France)	11.80%
	Minatome (France)	7.58%
	Mokta (France)	7.58%
	Urangesellschaft (FRG)	6.54%
	Agip (Italy)	6.54%
4. Akouta (Compagnie Miniere d'Akouta—Cominak)	Onarem	31%
	Cogema	34%
	OURD (Japan)	25%
	Enusa (Spain)	10%
5. Arni (Societe Miniere de Tassa N'Taghalque—SMTT)	Onarem	50%
	Cogema	50%
6. Imouraren	Onarem	30%
	Cogema	35%
	Conoco (US)	35%
7. Afasto-Ouest	Onarem	37.5%
	Cogema	37.5%
	OURD	25.0%
8. Djado Basin	Onarem	50%
	Pan Ocean Oil (Canada)	50%
9. In-Adrar	Onarem	33%
	Cogema	26%
	AEOI (Iran)	26%
	Agip	15%
10. Aracca-Oxoco	Onarem	50%
	Aracca-Oxoco	50%

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[1] ONAREM—Office National des Resources Miniere—a national company established by the Ministry of Mines and Water Resources of the Republic of Niger.

predominant mineral is coffinite. Ore reserves have been estimated at about 66,000 tonnes U, making it the largest single uranium deposit in Niger. The project is in an advanced stage of engineering. Indications are that a production rate of 3,000 tonnes U per year could be attained from large scale open pit mining and conventional milling.

Several uranium occurrences in the Afasto-Ouest permit area are currently being evaluated. The area is located southwest of Akouta. Geologically, the prospects are favorably located on an apparent extension of the Akouta ore trend, but on the west side of the Arlit fault. The Mineralization is at a depth of 750 feet—the deepest ore to be considered for development.

Other exploration projects are going ahead in Djado Basin and along the Algerian border. The In-Adrar concession, south of Imouraren, and the Aracca-Oxoco concession in southern Niger are inactive. Figure 4 shows the approximate location of the uranium deposits of The Republic of Niger.

Production

Uranium production totaled about 3,500 tonnes U (about 9,100,000 pounds U_3O_8) from the Arlit and Akouta projects in 1979. Annual production is scheduled to expand to 2,300 tonnes U at Arlit and 2,200 tonnes U at Akouta to bring total annual production capacity up to 4,500 tonnes U by the end of 1981. However, both expansion programs are behind schedule and the 1981 completion date may not be attainable.

The program to expand production at the two producing mines and the start-up of new mines was included as a basic economic consideration in the Niger government's Five-year Development Plan for the period 1979 through 1984. The fact that expansion plans are behind schedule at a time when the world uranium market is in disarray, will not doubt require thoughtful planning to preserve a developing industry that presently accounts for almost 75 percent of Niger's export trade.

Mineral Resource Policy

The government of Niger realized the economic potential of uranium development in the early days of prospecting. The government formed a national company—the Office National des Ressources Miniere (Onarem)—to coordinate all activities in exploration, exploitation and marketing of minerals within the Republic of Niger. Under its charter, Onarem can conduct independent exploration programs, and can participate in all exploration or mining activities in Niger. In this capacity, it holds title to the government interests in uranium projects and acts as the commercial partner in exploration and mining ventures.

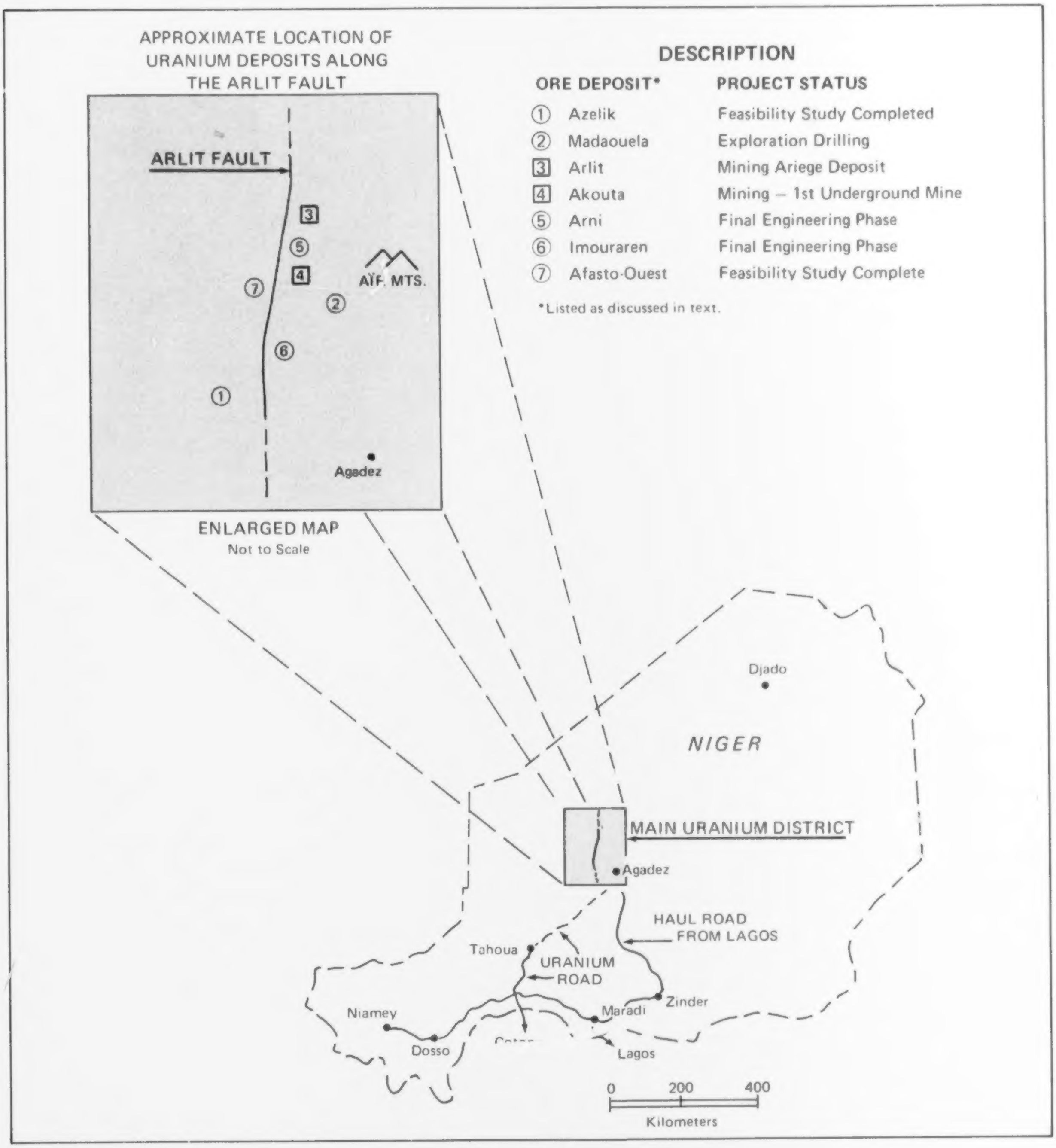
Under the Niger Mining Law of 1961, all mineral activities are regulated as follows:

- Prospecting permit is required before any work is performed. The term is six months to four years. It can be renewed twice for four years each.
- Exploration permit issued to parties capable of performing minimum requirements for specified area. The term is five years with two five-year renewals allowed. There are two types of permit. Type A covers large permit areas, one-half of which must be relinquished at first renewal, up to a quarter of remaining area at second renewal. Type B permit is issued on small tracts with no relinquishment required.
- Exploitation permit is granted for an exploitable mineral deposit located within the exploration permit area. Term is four years with four renewals possible.
- Mining concession is issued for large, exploitable mineral deposit. Technical and financial qualifications must be demonstrated to satisfaction of government. Term is 75 years with one or more renewals of 20 years as long as exploitation continues.

The Mining Law requires payment of a nominal fee at the time a permit is issued. Annual rental payments, based upon area, are required. The Law further provides that the government of Niger will obtain a free economic interest in all permits or concessions issued.

The business activities of uranium companies are regulated by a tax law enacted in 1968. The law imposes a 1% ad valorem tax on concentrates exported, a 4.5% ad valorem royalty on the mine value of concentrates in addition to the regular 40.5% tax on profits, and 16% tax on revenue derived by transferring securities. The law provides for allowable deductions and certain exemptions from turnover taxes and customs duties.

The mining and tax laws form the basis on which long term conventions can exist between companies and the government of Niger. These conventions de-


APPROXIMATE LOCATION OF URANIUM DEPOSITS ALONG THE ARLIT FAULT
ARLIT FAULT
3
5
4
AÏR MTS.
7
2
6
1
Agadez
ENLARGED MAP
Not to Scale
Djado
NIGER
MAIN URANIUM DISTRICT
Agadez
HAUL ROAD FROM LAGOS
Tahoua
URANIUM ROAD
Zinder
Maradi
Niamey
Dosso
Lagos
0
200
400
Kilometers

DESCRIPTION

ORE DEPOSIT*		PROJECT STATUS
①	Azelik	Feasibility Study Completed
②	Madaouela	Exploration Drilling
3	Arlit	Mining Ariege Deposit
4	Akouta	Mining – 1st Underground Mine
⑤	Arni	Final Engineering Phase
⑥	Imouraren	Final Engineering Phase
⑦	Afasto-Ouest	Feasibility Study Complete

*Listed as discussed in text.

Figure 4
LOCATION MAP OF KNOWN URANIUM DEPOSITS IN THE ARLIT DISTRICT, REPUBLIC OF NIGER

BEST AVAILABLE COPY

fine the rights and obligations of the parties. A foreign company or a foreign-controlled Nigerien company can do business in Niger, but it must obtain permission to do so.

Transportation

Transportation facilities—or lack of facilities—is one of the most perplexing problems confronting active uranium groups in Niger. There was virtually no road system in the Agadez region when the CEA entered the area in the 1950's. Twenty-five years later, a road system is beginning to develop, but problems still exist. There are no railroads in Niger. The lack of an adequate road and rail system contribute substantially to overall production costs.

The government is implementing a plan to ease the transportation problems. Truck shipments travel by way of an existing road from the town of Dosso via Tahoua and Agadez to Arlit. The road has been rebuilt as an all-weather road to Tahoua. The 650 km stretch of dirt road from Tahoua to Agadez and on to Arlit is presently being rebuilt as an all-weather road and should be completed in 1981 or early 1982. Construction of the "Uranium Road," as it is called, is being financed through loans from companies active in exploration and mining in Niger. Loan repayment will take place over a 20 year period, via a "Road Tax" on all uranium exported from Niger.

STATISTICAL DATA

EXCHANGE VALUE—31.50/lb U_3O_8
Determined as of July 31, 1980

Definition

The Exchange Value is Nuexco's judgment of the price at which transactions for significant quantities of natural uranium concentrates could be concluded as of the last day of the month.

Derivation

Nuexco bases the Exchange Value upon:

A. Data from recently completed transactions.
B. Data from pending transactions.
C. Firm bids to buy and firm offers to sell.
D. Prices purchasers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy, and prices sellers have expressed a willingness to accept, but for which Nuexco is not aware of firm offers to sell.

Comments

Nuexco does not consider the following in determining the Exchange Value:

A. The price of uranium delivered or to be delivered under old contracts.
B. The price of uranium delivered in connection with contract renegotiations or other than arm's length transactions.

TRANSACTION VALUE
Determined as of July 31, 1980

$/lb U_3O_8	Millions of Pounds	Number of Transactions	Number of Months
37.30	4.3	19	6

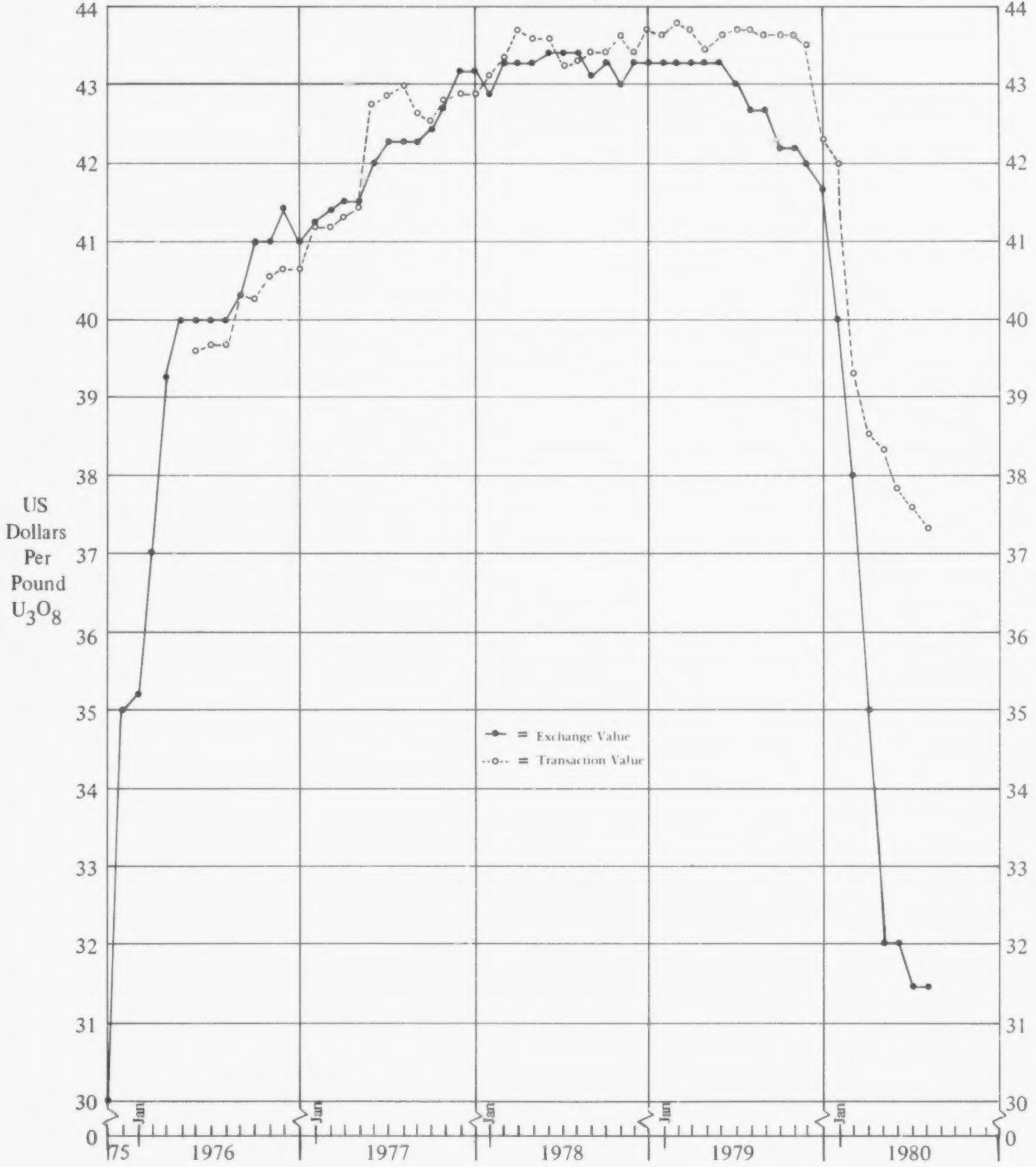
Definition

The Transaction Value is a weighted average price of recent transactions, and is based on prices paid for U_3O_8 in transactions closed within the previous three-month period and for which delivery was scheduled within one year of the transaction date. At least ten transactions totaling at least two million pounds U_3O_8 are included in each calculation, or the sample time is extended as necessary to include these minima. Foreign currencies are converted to US dollars as of the transaction date.

STATISTICAL DATA

EXCHANGE AND TRANSACTION VALUES SINCE NOVEMBER 1975

Determined as of the last day of the month indicated



STATISTICAL DATA

HISTORICAL EXCHANGE VALUES

Determined as of the last day of the month indicated
(US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1968	–	–	–	–	–	–	–	6.35	6.35	6.40	6.45	6.50
1969	–	6.35	6.10	6.10	6.25	6.25	6.20	6.20	6.15	6.15	6.15	6.20
1970	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.20	6.15	6.15	6.15	6.15
1971	6.20	6.20	6.20	6.20	6.15	6.05	6.00	5.95	5.95	5.95	5.95	5.95
1972	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95
1973	5.95	6.00	6.10	6.20	6.45	6.50	6.50	6.50	6.50	6.50	6.75	7.00
1974	7.70	7.90	8.00	9.00	9.50	10.50	11.50	12.00	12.50	14.00	14.75	15.00
1975	16.00	16.00	18.00	20.00	21.00	23.00	24.70	26.00	26.00	28.50	30.00	35.00
1976	35.20	37.00	39.25	40.00	40.00	40.00	40.00	40.40	41.00	41.00	41.50	41.00
1977	41.35	41.50	41.60	41.60	42.00	42.25	42.25	42.25	42.40	42.75	43.20	43.20
1978	42.90	43.25	43.25	43.25	43.40	43.40	43.40	43.10	43.25	43.00	43.25	43.25
1979	43.25	43.25	43.25	43.25	43.25	43.00	42.70	42.70	42.20	42.20	41.00	40.75
1980	40.00	38.00	35.00	32.00	32.00	31.50	31.50					

Note: See earlier Nuexco Reports for evolution of the definition of Exchange Value.

HISTORICAL TRANSACTION VALUES

Determined as of the last day of the month indicated
(US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1976	–	–	–	–	39.60	39.70	39.70	40.40	40.30	40.60	40.70	40.70
1977	41.30	41.30	41.40	41.50	42.80	42.90	43.00	42.60	42.50	42.80	42.90	42.90
1978	43.10	43.30	43.70	43.60	43.60	43.20	43.30	43.40	43.40	43.60	43.40	43.70
1979	43.60	43.80	43.70	43.40	43.60	43.70	43.70	43.60	43.60	43.60	43.50	42.30
1980	42.00	39.30	38.60	38.40	37.90	37.60	37.30					

Note: See Nuexco Report 135 for a discussion of the definition of Transaction Value.

NUEXCO

STATISTICAL DATA

EXCHANGE VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES*

Country	per lb U_3O_8 in Concentrates	per kg U_3O_8 in Concentrates	per kg U in Concentrates
US (dollar)	31.50	69.45	81.89
France (franc)	127.02	280.02	330.21
FRG (mark)	54.68	120.54	142.15
Japan (yen)	7,033	15,505	18,284
Switzerland (franc)	50.25	110.78	130.63
UK (pound)	13.15	29.00	34.19
Australia (dollar)	27.11	59.76	70.48
Canada (dollar)	36.34	80.13	94.49
Niger, Gabon (CFA)	6,351	14,001	16,511
South Africa (rand)	23.97	52.85	62.32

*Calculated using currency exchange rates published in the Wall Street Journal on the last Friday of the month.

LOAN USE CHARGE RATE—7.0%/year

Definition

The Loan Use Charge Rate is Nuexco's judgment of the annual interest rate at which uranium loans could be concluded as of the last day of the month.

Derivation

Nuexco bases the Loan Use Charge Rate upon:

A. Data from recently completed or pending loan transactions.
B. Rates included in firm proposals to borrow or lend.
C. Rates that potential borrowers and lenders have expressed a willingness to pay or accept, but for which Nuexco is not aware of firm proposals.

STATISTICAL DATA

CURRENT TRANSACTIONS*

Nuexco Reference Number	Delivery Period	Approximate Quantity (thousands of pounds, U_3O_8 equivalent)	Approximate Price as percent of Current E.V.	Seller Group	Buyer Group	Remarks
1154	80	100 – 300	99	US	Europe	
1155	80	50 – 100	–	US	Other	Enriched UF_6; definitive price info not available
1156	80	50 – 100	103	Canada	Canada	Not arms-length
1160	81	100 – 300	99	US	Europe	UF_6
1164	82-90	4000 – 7000	–	Australia	US	Definitive price info not available
1165	80	100 – 300	–	US	US	UF_6 loan; return in 1983
1166	81	100 – 300	–	US	US	UF_6 loan; return in 1983
1169	80	Less than 50	98	US	US	

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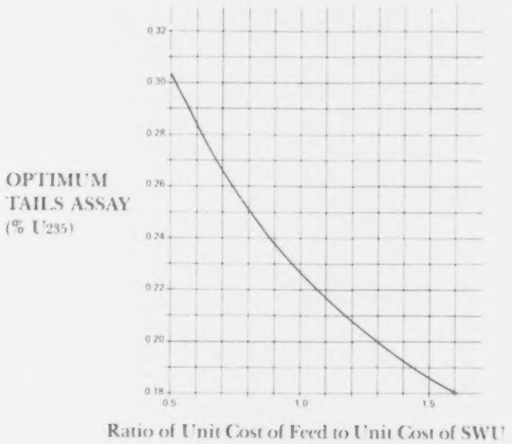
*Transactions listed include not only those in which Nuexco was involved, but also all others of which Nuexco is aware.

STATISTICAL DATA

OPTIMUM TAILS ASSAY

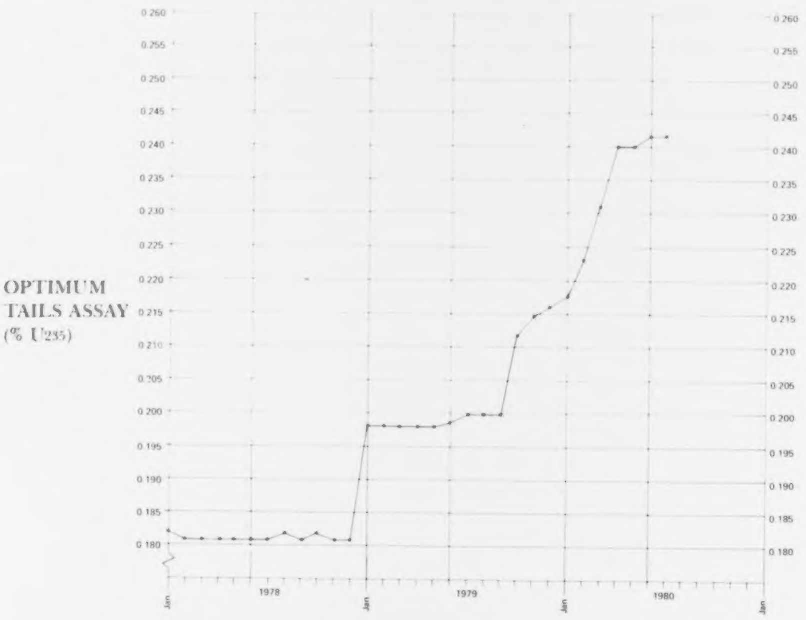
The optimum tails assay is the tails composition at which the cost of enriched uranium is lowest for given costs of separative work (SWU) and natural uranium feed. It depends only on the ratio of the cost of a kilogram of natural uranium in the form of UF_6 to the cost of a kilogram unit of separative work. The US Department of Energy (USDOE) Adjustable Fixed Commitment (AFC) enrichment contract holders have the option, within limits, to specify the transaction tails assay. The transaction tails assay for USDOE Requirements contracts is 0.2 percent U_{235}. For every one-hundredth of one percent increase in the transaction tails assay, uranium consumption increases about two percent.

TAILS ASSAY FOR MINIMUM COST OF PRODUCT*



*From Nuexco Report 138

HISTORICAL OPTIMUM TAILS ASSAY[1]



[1] Based on Exchange Value and USDOE AFC SWU price; interpolated to the nearest thousandth.

STATISTICAL DATA

US GOVERNMENT STATISTICS

	Producer Price Index—Industrial Commodities (1967 = 199)[1]	Consumer Price Index (1967 = 100)[2]	GNP Implicit Price Deflator (1972 = 100)[3]	Gross Average Hourly Earnings of Production or Non-supervisory Workers (US$)[4]		
				Metal Mining (SIC 10)	Primary Non-ferrous Metals (SIC 333)	Chemicals and Allied Products (SIC 28)
Annual Avg. 1970 (5)	110.0	116.3	91.36	3.88	3.87	3.69
Annual Avg. 1971 (5)	114.1	121.3	96.02	4.12	4.15	3.97
Annual Avg. 1972 (5)	117.9	125.3	100.00	4.56	4.59	4.26
Annual Avg. 1973 (5)	125.9	133.1	105.80	4.84	4.98	4.51
Annual Avg. 1974 (5)	153.8	147.7	116.02	5.44	5.63	4.88
Annual Avg. 1975 (5)	171.5	161.2	127.15	6.13	6.24	5.39
Annual Avg. 1976 (5)	182.4	170.5	133.71	6.76	6.87	5.91
Annual Avg. 1977 (5)	195.1	181.5	141.70	7.28	7.67	6.43
Annual Avg. 1978 (5)	209.4	195.4	152.05	8.23	8.56	7.01
Annual Avg. 1979	236.5	217.4	165.46	9.27	9.50	7.59
Apr 1979	229.0	211.5		9.03	9.49	7.50
May 1979	231.6	214.1	—	9.06	9.15	7.47
Jun 1979	234.0	216.6	163.81	9.09	9.44	7.53
Jul 1979	237.5	218.9	—	9.32	9.57	7.60
Aug 1979	240.6	221.1	—	9.38	9.70	7.65
Sep 1979	244.2	223.4	167.20	9.63	9.79	7.73
Oct 1979	249.0	225.4	—	9.67	9.87	7.82
Nov 1979	250.6	227.5	—	9.79	9.86	7.87
Dec 1979	253.1	229.9	170.58	9.80	9.92	7.91
Jan 1980	260.3	233.2	—	9.92	10.06	7.96
Feb 1980	265.4	236.4	—	9.93	10.01	7.99
Mar 1980	268.2	239.8	174.48R	9.91	10.23	8.04
Apr 1980	270.7	242.5	—	10.00	10.30	8.12
May 1980	271.2	244.9	—	10.12P	10.37P	8.16P
Jun 1980	273.0	247.6	—	—	—	8.24P

P = Preliminary R = Revised since last month

(1) US Bureau of Labor Statistics, Washington, D.C.; "Producer Prices and Price Indexes," Table 6 (formerly "Wholesale Prices and Price Indexes"). Producer Price Indexes are revised four months after they are first released to reflect the availability of late reports and corrections by respondents.

(2) US Bureau of Labor Statistics, Washington, D.C.; Consumer Price Index for All Urban Consumers, US City Average, All Items.

(3) US Department of Commerce, Washington, D.C.; Bureau of Economic Analysis, National Income and Wealth Division; "Survey of Current Business," Table A. The GNP Implicit Price Deflator is published quarterly, and seasonally adjusted.

(4) US Bureau of Labor Statistics, Washington, D.C.; "Employment and Earnings," Table C-2. All data based on 1972 revision of SIC Manual. Data for 1970-1976 are adjusted to the March 1977 benchmark. All data for 1977 and beyond are adjusted to the most recent benchmark—March 1978—and are subject to revision from that point forward, with the advent of the next benchmark scheduled for publication in late 1980.

(5) Data for 1970-1978, monthly except for the GNP Implicit Price Deflator, appear on pages 4.6 through 4.8 of Nuexco Report 139.

STATISTICAL DATA

AUSTRALIAN GOVERNMENT STATISTICS

	Price Index of Materials Used in Manufacturing Industry—All Groups (Year 1968-69 = 100.0)[1]	Weighted Average Minimum Weekly Wage Rates—Adult Males Australia Mining and Quarrying (A$)[2]
Annual Avg. 1970 (3)	101.4	59.88
Annual Avg. 1971 (3)	101.5	65.95
Annual Avg. 1972 (3)	105.6	71.26
Annual Avg. 1973 (3)	124.4	78.96
Annual Avg. 1974 (3)	141.9	108.07
Annual Avg. 1975 (3)	150.4	132.55
Annual Avg. 1976 (3)	168.4	160.93
Annual Avg. 1977 (3)	192.0	179.03
Annual Avg. 1978 (3)	215.4	190.04
Annual Avg. 1979	248.5	196.34
Feb 1979	253.0	190.19
Mar 1979	264.0	191.64
Apr 1979	274.0R	192.46
May 1979	288.5R	193.56
Jun 1979	294.9R	196.64
Jul 1979	298.2R	199.22
Aug 1979	293.2R	200.29
Sep 1979	302.4R	201.07
Oct 1979	309.4R	200.53
Nov 1979	310.4R	199.84
Dec 1979	319.4R	200.65
Jan 1980	340.1R	215.31R
Feb 1980	345.6	214.78R
Mar 1980	340.3P	214.22R
Apr 1980	326.6P	214.53
May 1980	—	214.07P

P = Preliminary R = Revised since last month

(1) Australian Bureau of Statistics, Canberra; "Price Index of Materials Used in Manufacturing Industry" (Catalogue No. 6411.0), Table 3.
(2) Australian Bureau of Statistics, Canberra; "Wage Rates, Australia" (Catalogue No. 6312.0), Table 1. Figures for the latest fourteen months shown are subject to revision.
(3) Monthly data for 1970 through 1978 appear on pages 4.7 and 4.8 of Nuexco Report 138.

STATISTICAL DATA

CANADIAN GOVERNMENT STATISTICS

	Industry Selling Price Index: Manufacturing (D 500000)[1,2] (1971 = 100.0)	Wage-earner Data: Average Hourly Earnings (C$)[3,4] Metal Mining, including milling (SIC 050-059)	Primary Metal Industries, non-ferrous (SIC 296-298)	Chemicals and Chemical Products (SIC 370-379)
Annual Avg. 1977	174.3	8.18	6.50	6.51
Annual Avg. 1978	190.4	8.76	6.82	6.97
Annual Avg. 1979	217.9	9.60	7.35	7.67
Mar 1979	210.4	9.47	7.20	7.51
Apr 1979	212.8	9.68	7.26	7.63
May 1979	214.5	9.65	7.28	7.61
Jun 1979	216.0	9.49	7.27	7.66
Jul 1979	218.3	9.37	7.34	7.73
Aug 1979	220.0	9.56	7.38	7.77
Sep 1979	223.4	9.75	7.50	7.81
Oct 1979	227.4	9.89	7.54	7.88
Nov 1979	228.1	9.97	7.61	7.91
Dec 1979	230.4	9.93	7.51	7.89
Jan 1980	238.9R	9.96	7.57	7.99
Feb 1980	240.6	10.11	7.69	8.08
Mar 1980	239.4R	10.34P	7.83	8.26P
Apr 1980	240.8	10.37P	7.94P	8.33P
May 1980	242.8P	—	—	—

P = Preliminary R = Revised since last month

(1) Statistics Canada, Prices Division, Ottawa; "Industry Price Indexes" (Catalogue 62-011), Table 1. Indexes for the most recent six months shown are subject to revision.
(2) Monthly data for 1973 through 1978 appear on page 4.10 of Nuexco Report 138.
(3) Statistics Canada, Labour Division, Employment and Payrolls Section, Ottawa; "Employment, Earnings and Hours" (Catalogue 72-002), Table 2.
(4) Monthly data for 1977 and 1978 appear on page 4.11 of Nuexco Report 138.

REPUBLIC OF SOUTH AFRICA STATISTICS

	Average Declared Working Costs per Metric Ton of Gold Ore Milled (Rand)[1]	Consumer Price Index[2] (1975 = 100, except where otherwise indicated)
Annual Avg. 1970(3)	7.34	100.3(4)
Annual Avg. 1971(3)	7.88	106.4(4)
Annual Avg. 1972(3)	8.79	113.3(4)
Annual Avg. 1973(3)	10.51	124.1(4)
Annual Avg. 1974(3)	13.18	138.5(4)
Annual Avg. 1975(3)	16.71	157.2(4)
Annual Avg. 1976(3)	19.30	174.7(4)
Annual Avg. 1977(3)	23.87	194.4(4)
Annual Avg. 1978(3)	27.14	137.2
Annual Avg. 1979(3)	30.18	155.3
Apr 1979	–	149.9
May 1979	–	150.6
Jun 1979	29.44	152.4
Jul 1979	–	157.9
Aug 1979	–	160.2
Sep 1979	30.71	162.1
Oct 1979	–	162.9
Nov 1979	–	163.4
Dec 1979	31.89	164.0
Jan 1980	–	165.4
Feb 1980	–	167.0
Mar 1980	33.65	168.0
Apr 1980	–	170.0
May 1980	–	171.9
Jun 1980	–	174.6

---

(1) Chamber of Mines of South Africa, Johannesburg; "Analysis of Working Results," published quarterly.

(2) Republic of South Africa Department of Statistics, Pretoria; "Government Gazette: Consumer Price Index for Urban Areas."

(3) Historical data for 1970 through 1979 appear on page 4.9 of Nuexco Report 140.

(4) April 1970 = 100.00

MARKET OPPORTUNITIES

Market Opportunities are *active* inquiries in the uranium market to buy, sell, borrow or lend. The data presented in this section are in no way intended to be indicative of the entire uranium market for the time period covered.

URANIUM SUPPLY

Nuexco Reference Number	Delivery Period (Thousands of Pounds U_3O_8) 1980	1981	1982	1983	Remarks
Available for Sale:					
1213	150				
1236			150	150	
1274	150				
1284	250				
1286		150	150	150	
1315			200	200	
1325	750				
1338	250				
1346	200				
1392	300				
1394	250				
1465	25				
1475	1000				UF_6
TOTALS	3325	150	500	500	

Available for Loan:					
1175	700				UF_6
1234	700				
1354	600				UF_6
1355	600				
1429	500				
TOTAL	3100				

MARKET OPPORTUNITIES

Market Opportunities are *active* inquiries in the uranium market to buy, sell, borrow or lend. The data presented in this section are in no way intended to be indicative of the entire uranium market for the time period covered.

URANIUM DEMAND

Nuexco Reference Number	Delivery Period (Thousands of Pounds U_3O_8) 1980	1981	1982	1983	Remarks
Inquiries to Purchase:					
1146		100	200	200	
1406	50				
1408	150				
1410		2000	2000	2000	
1459			200	200	
1462				100	
1468		1000			
1470	25				
TOTALS	225	3100	2400	2500	
Inquiries to Borrow:					
1220	500				

MARKET OPPORTUNITIES

Market Opportunities are *active* inquiries in the secondary market for UF_6 conversion services. The data presented in this section are in no way intended to be indicative of the entire market for the time period covered.

CONVERSION SUPPLY

Nuexco Reference Number	Delivery Period (Thousands of Pounds U as UF_6)				Remarks
	1980	1981	1982	1983	
P-1282	250	250			
P-1424	1000				
P-1449		750			
P-1450	750				
P-1451	175				
P-1474	50				Non-U.S.
TOTALS	2225	1000			

CONVERSION DEMAND

Nuexco Reference Number	Delivery Period (Thousands of Pounds U as UF_6)				Remarks
	1980	1981	1982	1983	
P-1424-A	190				

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NUEXCO

SEPTEMBER 1980 NUMBER 145

Monthly Report on the Uranium Market

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NUEXCO

MONTHLY REPORT ON THE URANIUM MARKET

September 1980 No. 145

JAMES E. VAUGHAN, *EDITOR*

FOREWORD ii

THE URANIUM MARKET

GENERAL 1
  Supply and Demand Balance 1
  Forecast of US Uranium Production 5
  US Government Statistics 6
AUSTRALIA 6
CANADA 9
EUROPE 10
FAR EAST 10
UNITED STATES 10
TRANSACTIONS 12
PRICING 12
CONVERSION 12

TOPICAL ESSAY

HISTORICAL PERSPECTIVE ON US URANIUM PRODUCTION 13

RAW MATERIALS

URANIUM IN ARGENTINA 17

STATISTICAL DATA

EXCHANGE AND TRANSACTION VALUES 21
LOAN USE CHARGE RATE 24
CURRENT TRANSACTIONS 25
OPTIMUM TAILS ASSAY 26
GOVERNMENT STATISTICS 27

MARKET OPPORTUNITIES

URANIUM SUPPLY 31
  Available for Sale
  Available for Loan
URANIUM DEMAND 32
  Inquiries to Purchase
  Inquiries to Borrow
CONVERSION SUPPLY AND DEMAND 33

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FOREWORD

We are delighted to announce that Mr. R. K. (Dick) Andersen is joining Nuexco this month as Vice President and Senior Consultant. Dick will develop a consulting division to complement our information services and brokerage activities. Nuexco has been passive about accepting special consulting assignments in the past. However, the large number of requests from Subscribers for us to provide this type of service has led us to change this position.

Dick Andersen began his career in the nuclear power industry in 1950 with the General Electric Company at the Hanford works. He transferred to the Company's commercial nuclear division in San Jose, California, in 1955. From 1968 to 1976, he was a partner in a consulting business, with his area of responsibility that of uranium and the nuclear fuel cycle. In 1976, he rejoined General Electric as a senior member of its strategic planning operations.

URANIUM MARKET

GENERAL

Supply and Demand Balance

In Report 142, Nuexco published an analysis of world uranium supply and demand. The analysis concluded that:

1. *Firm supply* (defined as supply from uranium production centers operating or under construction) appeared more than sufficient to satisfy *consumption* (defined as uranium entering the enrichment-fabrication pipeline) on a worldwide basis through 1990.

2. In addition, firm supply appeared adequate to increase worldwide inventory levels to approximately 3.5 years of forward consumption by 1990.

In Report 144, Nuexco published revised estimates of apparent future consumption. Also this month's Report contains Nuexco's revised forecast of US uranium production. This section analyzes the resultant changes in the worldwide supply and demand balance, following some prefatory comments on definitions and computational groundrules.

1. Nuexco's estimates of apparent future consumption are sometimes confused with estimates of uranium burnup in reactors. Actually, apparent future consumption, as defined by Nuexco, is natural uranium concentrate which utilities would need to deliver in a given year for enrichment and fabrication and later use in a reactor. Thus, *consumption* is the fundamental component of uranium demand. These estimates apply only to the assumed pattern of additions to installed nuclear electric generating capacity, and they make no allowance for earlier or greater demand associated with contracts for conversion, enrichment or fabrication.

2. With respect to production outside the US, the critical assumption in this supply-demand analysis is that uranium production centers in operation or currently under construction will be able to sell their projected U_3O_8 output, even if only for inventory accumulation in a time of apparent excess supply.

3. With respect to US production centers, the critical element in this supply-demand analysis is the degree to which producers having existing contracts will elect to purchase rather than produce uranium.

4. To the extent that actual annual demand exceeds consumption, inventory is accumulated.

5. Planned production centers—those with production plans and identified ore reserves, but for which construction has not yet begun—are not considered in this analysis.

6. It is important to note that estimates of apparent future consumption take no account of reactors not yet ordered. Consequently, consumption estimates will understate actual demand by the amount attributable to orders yet to be placed, as well as by inventory purchases.

7. In order to facilitate understanding of the concept of apparent future consumption other aspects of Nuexco's methodology are summarized as follows:

a. Apparent future consumption should be regarded as a comparatively hard component of total demand, and is relatively insensitive to uranium prices. Market demand *for the assumed pattern of additions to nuclear electric generating capacity* can be higher, but is not likely to be much lower.

b. Actual demand can exceed apparent future consumption because of accelerated reactor construction schedules or inventory purchases by utilities.

c. Reactor loading is calculated for each reactor based on its individual core characteristics. It is assumed that: 1) U_3O_8 deliveries for first cores predate commercial operation by two years; 2) first reload occurs 12 months after commercial operating date and annually thereafter (in some cases, actual reload schedule is substituted for the assumed 12-month interval); 3) U_3O_8 delivery for each reload predates reload by 18 months.

d. Actual commercial operating dates can differ widely from published dates. Nuexco uses the best information available, much of it from unpublished sources.

e. Reactors fueled by the USSR are excluded.

8. Inventory refers to natural uranium inventory (U_3O_8 and UF_6) owned by utilities, reactor manufacturers, fuel fabricators and national organizations which procure uranium for commercial purposes. The inventory amounts do not include strategic stockpiles, such as those owned by the US Department of Energy (USDOE). Difficulties in accounting precisely for the variety of possible forms, locations and ownership of uranium inventory necessarily result in some uncertainty in estimating the total world natural uranium inventory. Nuexco's estimate of worldwide commercial natural uranium inventory as of the beginning of 1979 is approximately 160 million pounds; however, the uncertainty factor of this estimate is ten to fifteen percent. More important is the fact that the primary conclusions of this analysis are not sensitive to beginning inventory vari-

URANIUM MARKET

ations of ten to fifteen percent.

Analyses of the uranium supply and demand balance were conducted for each of the following regions: (1) world outside Communist areas (WOCA); (2) US; (3) non-US WOCA.

Table 1 tabulates Nuexco's analysis of the uranium supply and demand balance for the world outside Communist areas (WOCA). Conclusions which may be drawn from the analysis include the following:

1. Firm supply exceeds consumption in each year through 1990. Supply and demand can be balanced by additions to inventory. In actual practice, if supply exceeds demand over an extended period, the necessary balance would probably result from a combination of inventory purchases and reduced production.

2. The world inventory of 160 million pounds at the beginning of 1979 is equivalent to 2.3 years of forward consumption at the 1979 rate. The analysis indicates that the 1980 beginning inventory of approximately 190 million pounds will more than double by 1990, to approximately 385 million pounds U_3O_8 equivalent. That quantity corresponds to approximately 3.3 years forward consumption at the 1990 rate. In fact, the analysis indicates a very stable relative inventory level throughout the decade; each year's relative inventory level falls in the range of 3.1 to 3.3 years forward consumption.

The relative inventory level of approximately three years forward consumption represents a substantial increase over the data published just ten months ago in Nuexco Report 135. At that time, this same type of analysis indicated a fairly stable relative inventory level of 2.0 to 2.3 years forward consumption. The difference is almost solely attributable to the substantial reductions in Nuexco's estimates of apparent future consumption, which have taken place since then.

3. If actual demand is to be sufficient to support production from production centers planned, but not yet under construction, it may arise from new reactor orders, or from political or national policy considerations. However, it is more likely that the driving force behind any such additional production entering the market would be the displacement of other higher-cost production centers.

Table 2 shows Nuexco's current analysis of the uranium supply and demand balance for the US. By treating the US alone, the potential market can be identified not only for imports, but also for potential US production centers not yet under construction.

The anlaysis in Table 2 is of the same basic form described above, but with the addition of an adjustment for *firm* US export-import commitments. The result is an annual supply surplus or deficit for the US. If the annual result is a supply surplus, it is assumed to have been added to buyer inventories. If the annual result is a supply deficit, it is assumed to have been removed from buyer inventories. The annual beginning and ending inventory levels are also tabulated in Table 2 along with the relative inventory level for that year, in years of forward consumption. Table 2 indicates an annual US supply deficit beginning in 1983 and growing to an annual level of more than 25 million pounds by 1985. Without additional imports or new US supply, US inventory would decline to a level equivalent to 18 months forward consumption by 1986. Under the groundrules of this analysis, US inventories would be completely liquidated in 1988.

Based on these results, it appears that the US will be dependent to a large extent upon imported uranium by the mid-1980's. Thus it is likely that US users, as a group, will desire to maintain a commercial inventory of uranium. Tables 3 and 4 were developed under the assumption that US utilities would maintain a collective inventory level equivalent to at least 18 months foward consumption. The two most important assumptions in computing the data in Table 3 are as follows:

1. When, after taking into account exports, imports and annual consumption, annual US production is enough, or more than enough, to maintain inventory equivalent to 18 months forward consumption, any excess production will be added to inventory.

2. When, after taking into account exports, imports and annual consumption, annual US production is insufficient to maintain inventory equivalent to 18 months forward consumption, US buyers will acquire the additional uranium through some combination of increased imports, increased purchases from US facilities operating or under construction, and purchases from new US production centers not yet under construction.

If, as assumed in Table 3, US buyers maintain a

URANIUM MARKET

Table 1
NATURAL URANIUM SUPPLY-DEMAND BALANCE: WOCA[1]
(millions of pounds U_3O_8)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
PRODUCTION[2]												
Operating Production Centers	98.5	103.3	105.8	101.3	101.8	101.1	101.1	100.1	99.2	99.0	99.0	99.0
Facilities under Construction	-0-	0.6	6.4	8.9	12.9	17.7	19.8	20.8	20.6	20.6	20.6	20.6
Total	98.5	103.9	112.2	113.2	117.7	121.8	120.9	120.9	119.8	119.6	119.6	119.6
less												
CONSUMPTION[3]	68.7	57.7	74.1	85.3	93.9	100.2	113.4	112.5	113.7	114.1	115.0	114.1
equals												
NET INVENTORY INCREASE	29.8	46.2	38.1	27.9	23.8	21.6	7.5	8.4	6.1	5.5	4.6	5.5
plus												
BEGINNING INVENTORY	160.0[4]	189.8	236.0	274.1	302.0	325.8	347.7	354.9	363.3	369.4	374.9	379.5
equals												
ENDING INVENTORY	189.8	236.0	274.1	302.0	325.8	347.4	354.9	363.3	369.4	374.9	379.5	385.0
RELATIVE INVENTORY[5] (yrs)	2.3	3.3	3.2	3.2	3.2	3.3	3.1	3.2	3.2	3.3	3.3	3.3

[1] World outside Communist areas.
[2] This Report, Table 9.
[3] Natural uranium entering enrichment-fabrication pipeline for later use in a reactor. Nuexco Report 144, Table 1.
[4] Nuexco Estimate.
[5] For each year, Relative Inventory equals Beginning Inventory divided by Consumption.

Table 2
NATURAL URANIUM SUPPLY-DEMAND BALANCE: US
(millions of pounds U_3O_8)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
PRODUCTION[1]												
Operating Production Centers	37.0	34.2	29.3	26.0	24.7	22.0	19.0	17.1	16.3	16.2	16.2	16.2
Facilities Under Construction	-0-	0.3	2.0	2.5	2.7	3.0	3.0	3.0	2.8	2.8	2.8	2.8
Total	37.0	34.5	31.3	28.5	27.4	25.0	22.0	20.1	19.1	19.0	19.0	19.0
less												
CONSUMPTION[2]												
Reactors Now Operational	16.3	17.4	17.4	17.1	18.0	18.0	18.1	17.4	17.6	18.3	18.2	17.7
Now Under Construction	8.5	0.7	7.5	12.8	17.2	22.2	25.4	30.0	27.1	30.3	27.2	27.6
Now On Order	-0-	-0-	-0-	-0-	-0-	-0-	-0-	0.9	0.3	0.3	3.4	2.0
Total	24.8	18.1	24.9	29.9	35.2	40.2	43.5	48.3	45.0	48.9	48.8	47.3
plus												
NET IMPORTS (EXPORTS)[3]	(1.8)	(1.9)	0.3	1.5	1.2	1.7	0.1	0.6	0.6	0.6	1.0	1.1
equals												
SUPPLY SURPLUS (DEFICIT)	10.4	14.5	6.7	0.1	(6.6)	(13.5)	(21.4)	(27.6)	(25.3)	(29.3)	(28.8)	(27.2)
plus												
BEGINNING INVENTORY	66.4[4]	76.8	91.3	98.0	98.1	91.5	78.0	56.6	29.0	3.7	-0-	-0-
equals												
ENDING INVENTORY	76.8	91.3	98.0	98.1	91.5	78.0	56.6	29.0	37.0	-0-	-0-	-0-
RELATIVE INVENTORY (yrs)[5]	2.7	4.2	3.7	3.3	2.8	2.3	1.8	1.2	0.6	0.1	-0-	-0-

[1] This Report, Table 7.
[2] Nuexco Report 144, Table 1.
[3] Nuexco Report 142, Table 3.
[4] George F. Combs, Jr.: "The US Uranium Market—1978-1979" USDOE; Grand Junction, Colorado; October, 1979.
[5] For each year, Relative Inventory equals Beginning Inventory divided by Consumption.

minimum inventory level of 18 months forward consumption, an *unfilled US demand* would be created as follows (millions of pounds U_3O_8):

	1985	*1986*	*1987*	*1988*	*1989*	*1990*
Annual	15.9	22.6	31.2	29.2	26.6	28.2
Cumulative	15.9	38.5	69.7	98.8	125.4	153.6

Thus, if US buyers' inventory policies take the form assumed in Table 3, the cumulative market for imports and new additions to US production will total approximately 150 million pounds U_3O_8 through 1990. This figure is essentially the same as the previous Nuexco estimate, published in Report 142. This is because the decreases in Nuexco's estimates of US apparent future consumption have been largely offset by decreases in Nuexco's estimates of US production.

If the US imports an additional 150 million pounds U_3O_8 through 1990, the effect on the rest of the world's uranium supply and demand balance could be substantial. Table 4 was developed to estimate this effect. Table 4 tabulates the supply-demand balance of the world outside the US and outside Communist areas, under the assumption that the US will import as necessary to maintain at least 18 months forward consumption in inventory. The analysis indicates an increase in relative inventory level from 2.9 years at the beginning of 1980 to almost five years by 1990. Even after projected exports to the US are deducted from production, there is a substantial supply surplus in each year through 1990. This analysis shows inventories outside the US nearly tripling, from approximately 113 million pounds in 1980 to 313 million pounds in 1990.

The conclusions to this analysis are similar to those of Report 142, namely that the additional delays and cancellations of reactor projects combined with apparently ample future uranium availability are leading to an increasingly competitive uranium market.

Table 3

NATURAL URANIUM SUPPLY-DEMAND BALANCE: US

(Assumes US Buyers Maintain At Least 18 Months Forward Consumption in Inventory)
(millions of pounds U_3O_8)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
CONSUMPTION[1]	24.8	18.1	24.9	29.9	35.2	40.2	43.5	48.3	45.0	48.9	48.8	47.3
CONSUMPTION x 1.5	37.2	27.2	37.4	44.9	52.8	60.3	65.3	72.5	67.5	73.4	73.2	71.0
MINIMUM ENDING INVENTORY[2]	27.2	37.4	44.9	52.8	60.3	65.3	72.5	67.5	73.4	73.2	71.0	72.0
BEGINNING INVENTORY	66.4[3]	76.8	91.3	98.0	98.1	91.5	78.0	72.5	67.5	73.4	73.2	71.0
plus												
ANNUAL SUPPLY SURPLUS (DEFICIT)[4]	10.4	14.5	6.7	0.1	(6.6)	(13.5)	(21.4)	(27.6)	(25.3)	(29.3)	(28.8)	(27.2)
equals												
NOMINAL ENDING INVENTORY[5]	76.8	91.3	98.0	98.1	91.5	78.0	56.6	44.9	42.2	44.1	44.4	43.8
UNFILLED DEMAND[6]	-0-	-0-	-0-	-0-	-0-	-0-	15.9	22.6	31.2	29.1	26.6	28.2
ADJUSTED ENDING INVENTORY[7]	76.8	91.3	98.0	98.1	91.5	78.0	72.5	67.5	73.4	73.2	71.0	72.0
RELATIVE INVENTORY (yrs)[8]	2.7	4.2	3.7	3.3	2.8	2.3	1.8	1.5	1.5	1.5	1.5	1.5

[1] Nuexco Report 144, Table 1.
[2] Needed to make Ending Inventory (year N) equal 1.5 times Consumption (year N + 1).
[3] George F. Combs, Jr.: "The US Uranium Market—1978-1979" USDOE; Grand Junction, Colorado; October, 1979.
[4] This Report, Table 2.
[5] Nominal Ending Inventory is the unadjusted sum of Beginning Inventory and the annual supply surplus (deficit).
[6] Unfilled US demand is defined as that additional amount of uranium, if any, which US buyers would have to purchase over and above US firm production in order to maintain a minimum relative inventory of 1.5 years forward consumption.
[7] Adjusted Ending Inventory is the sum of Nominal Ending Inventory and Unfilled US Demand.
[8] For each year, Relative Inventory equals Beginning Inventory divided by Consumption.

Table 4

NATURAL URANIUM SUPPLY-DEMAND BALANCE: WOCA OUTSIDE US

(Assumes US Maintains Minimum Inventory of 18 Months Forward Consumption by Importing)
(millions of pounds U_3O_8)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
PRODUCTION[1]												
Operating Production Centers	61.5	69.1	76.5	78.3	80.1	82.1	82.1	83.0	82.9	82.8	82.8	82.8
Facilities Under Construction	-0-	0.3	4.4	6.4	10.2	14.7	16.8	17.8	17.8	17.8	17.8	17.8
Total	61.5	69.4	80.9	84.7	90.3	96.8	98.9	100.8	100.7	100.6	100.6	100.6
less												
CONSUMPTION[2]												
Reactors Now Operational	19.7	21.4	21.4	21.4	21.4	21.5	21.5	21.5	21.5	21.5	21.5	21.5
Now Under Construction	24.2	18.2	27.8	33.1	33.2	31.0	33.2	33.2	32.3	32.3	32.3	32.3
Now On Order	-0-	-0-	-0-	0.9	4.1	7.5	15.2	9.5	14.9	11.4	12.4	13.0
Total	43.9	39.6	49.2	55.4	58.7	60.0	69.9	64.2	68.7	65.2	66.2	66.8
plus												
NET IMPORTS (EXPORTS)[3]	1.8	1.9	(0.3)	(1.5)	(1.2)	(1.7)	(0.1)	(0.6)	(0.6)	(0.6)	(1.0)	(1.1)
less												
ADDITIONAL EXPORTS[4]	-0-	-0-	-0-	-0-	-0-	-0-	15.9	22.6	31.2	29.1	26.6	28.2
equals												
SUPPLY SURPLUS	19.4	31.7	31.4	27.8	30.4	35.1	13.0	13.4	0.2	5.7	6.8	4.5
plus												
BEGINNING INVENTORY	93.6[5]	113.0	144.7	176.1	203.9	234.3	269.4	282.4	295.8	296.0	301.7	308.5
equals												
ENDING INVENTORY	113.0	144.7	176.1	203.9	234.3	269.4	282.4	295.8	296.0	301.7	308.5	313.0
RELATIVE INVENTORY (yrs)[6]	2.1	2.9	2.9	3.2	3.5	3.9	3.9	4.4	4.3	4.5	4.6	4.6

[1] Nuexco Report 141, pg. 1.2.
[2] Nuexco Report 144, Table 1.
[3] Nuexco Report 142, Table 3. Non-US exports equal US imports and vice versa.
[4] Additional Exports to the US needed by the US to maintain a minimum inventory of 18 months forward consumption. Ref. this Report, Table 3, Unfilled Demand.
[5] Nuexco estimate.
[6] For each year, Relative Inventory equals Beginning Inventory divided by Consumption.

Forecast of US Uranium Production

Nuexco presented estimates of US and world production of U_3O_8 in Report 141. In recognition of the market conditions prevailing at that time, those estimates were based only on facilities which were operating or under construction as of April 30, 1980. The following is excerpted from Report 141:

> *. . . In the US, some existing facilities have begun to reduce production. Some can be expected to suspend production within the next one to three years if present trends continue. The estimate of US uranium production presented in this Report is based upon Nuexco's assessment of the probable output of each producer, which in turn is based upon estimated production cost, ore reserves, and sales commitments.*

Over the past 9 to 12 months, the economics of uranium production have been changing quite rapidly. As spot market prices have dropped, the amount of current US production which has become vulnerable to premature shutdown has increased. In addition, plans for construction of additional facilities have been and continue to be reviewed and re-evaluated. At the same time, heightened awareness of rising world inventory levels has increased the likelihood of a prolonged buyers' market.

The forecast of US production presented herein necessarily reflects some subjective opinions about commercial decisions which will be faced over the next few years by US producers. Those decisions will be based on many factors, but the ultimate outcome of production decisions in the US will most probably be determined by the economics of free market competition.

Unlike the US, many other nations have national nuclear power policies. The active promotion of such policies by the governments of those countries allows them to use longer planning horizons than their US counterparts. Additionally, much of the important production outside the US is dedicated to attaining and sustaining national self-sufficiency in the nuclear fuel cycle, or at least in nuclear raw materials. For these reasons, much of what might otherwise be either economically marginal, or excess uranium production outside the US will continue in operation. In addition, much non-US production will be from the high-grade deposits of Australia and Canada, and the by-product production of South Africa. These low cost operations can be expected to continue producing for the foreseeable future. Therefore, the non-US supply figures used in this Section are the same as Nuexco's estimate of U_3O_8 production outside the US as published in Report 141.

Production centers are divided into categories, according to stage of development, as follows:

1. Operating production centers—those which have shipped U_3O_8 in commercial quantities before September 1, 1980.
2. Production centers under construction—those which were being built as of August 31, 1980, and which have an established access to ore reserves. Conventional production centers are included in this category only if mill construction has actually begun.

Each category is further divided, according to source, as follows:

—Conventional milling

—Unconventional recovery methods

- Solution mining, including *in situ* leaching and hydraulic mining.
- Phosphoric acid by-product recovery.
- Heap leaching, including leachings of tailings and copper dumps.

Operating US production centers are listed in Table 5. Centers under construction are listed in Table 6. Table 7 summarizes the estimated U_3O_8 production for each category.

Annual US production is expected to decline from the 1979 level of about 37 million pounds U_3O_8 to about 34 million pounds in 1980 and to about 20 million pounds in 1986. The decrease is due to declining ore grades, depletion of orebodies and production cutbacks due to high costs and low prices.

Table 8 tabulates estimated world uranium production by region; Table 9 contains the same production estimates segmented according to status of the production center. World production for 1979 totalled approximately 99 million pounds U_3O_8, of which non-US production accounted for 62 percent. Table 8 shows the US portion of the world's uranium production declining steadily from its 1979 level of 38 percent.

US Government Statistics

Beginning with the July 1980 issue of "Employment and Earnings," the US Bureau of Labor Statistics (BLS) has adjusted data to the most recent benchmark, that of March 1979. Revised average hourly earnings data for the period January 1977 through March 1980 will be published in a forthcoming supplement to "Employment and Earnings." As soon as possible thereafter, these revised historical data will be reprinted in the Nuexco Report.

The USBLS annually adjusts its industry employment series to more recent benchmarks. Normally, new benchmarks are determined for March of each year. Generally, new benchmarks do not change average hourly earnings data by more than one cent.

There are four basic reasons for the differences between benchmarks and estimates: (1) errors in trends caused by nonrepresentative samples, (2) errors in adjustment for the entry of new firms, (3) improvements in the quality of the benchmark data, and (4) changes in industrial classification of individual establishments.

AUSTRALIA

On August 18 Australian Deputy Prime Minister Anthony announced the initialling of contracts calling for the delivery from the Ranger deposit of about 68 million pounds U_3O_8 over the fifteen year period 1982-1996. Based on previous information, the breakdown of the purchase is tabulated in Table 10.

These transactions provide the basis for the establishment of Energy Resources of Australia (ERA) as a viable uranium venture, including the purchase by Peko-Wallsend and EZ Industries of the government's 50 percent share of Ranger, the financing of the mine

Table 5
OPERATING US PRODUCTION CENTERS

CONVENTIONAL MILLS

- Anaconda Corp.; Grants, NM
- Atlas Minerals Corp.; Moab, UT
- Chevron Resources; Pannamaria, TX
- Conoco-Pioneer Nuclear JV; Falls City, TX
- Cotter Corp; Canon City, CO
- Dawn Mining Co.; Ford, WA
- Energy Fuels; Blanding, UT
- Exxon Minerals Co. USA; Powder River Basin, WY
- Federal-American Partners; Gas Hills, WY
- Kerr-McGee Nuclear; Grants, NM
- Pathfinder Mines Corp.; Gas Hills, WY
- Pathfinder Mines kCorp.; Shirley Basin, WY
- Petrotomics Co.; Shirley Basin, WY
- Rio Algom Corp.; La Sal, UT
- Rocky Mountain Energy; Bear Creek, WY
- Sohio-Reserve; Seboyeta, NM
- Union Carbide Corp.; Uravan, CO
- Union Carbide Corp.; Gas Hills, WY
- United Nuclear Corp.; Church Rock, NM
- United Nuclear-Homestake Partners; Grants, NM
- Western Nuclear, Inc.; Jeffrey City, WY
- Western Nuclear, Inc.; Sherwood, WA

UNCONVENTIONAL SOURCES

Solution Mining:

- Everest Mineral Corp.; Hobson TX
- IEC Corp.; Ray Point, TX
- Mobil Oil Corp.; Holiday El Mesquite, TX
- Mobil Oil Corp.; Ohern, TX
- Uranium Resources Corp.; Bruni, TX
- Uranium Resources-Framco-Conoco JV; Benevedes, TX
- US Steel Corp.; George West, TX
- US Steel-NM Uranium; Clay West, TX
- Wyoming Mineral Corp.; Iragaray, WY
- Wyoming Mineral Corp.; Bruni, TX
- Wyoming Mineral Corp.; Ray Point, TX

Phosphoric Acid By-product:

- Freeport Uranium Recovery Corp.; Uncle Sam LA
- Gardinier, Inc.; Tampa, FL
- IMC Corp.; New Wales, FL
- Wyoming Mineral Corp.; @ Farmland Industries, Pierce, FL

Heap Leaching:

- Anamax Mining Co.; Sahuarita, AZ
- Solution Engineering, Inc.; Falls City, TX
- Union Carbide Corp.; Maybell, CO
- Wyoming Mineral Corp.; Bingham Canyon, UT

Table 6
US PRODUCTION CENTERS UNDER CONSTRUCTION

CONVENTIONAL MILLS

- Bokum Resources; Marquez, NM
- Minerals Exploration; Sweetwater, WY
- Plateau Resources; Shootering Canyon, UT

UNCONVENTIONAL SOURCES

Solution Mining

- Caithness Corp.; Bruni, TX
- Mobil Oil Corp.; Nell, TX
- Mobil Oil Corp.; Piedre Lumbre & Brelum, TX

Phosphoric Acid By-product:

- Earth Sciences; Calgary, Alberta
- Freeport Uranium Recovery Corp. @ Agrico; Faustina, LA
- IMC Corp. @ CF Industries; Plant City, FL
- IMC Corp. @ CF Industries; Bartow, FL

Table 7
US URANIUM PRODUCTION FORECAST
(millions of pounds U_3O_8)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
OPERATING												
Conventional Mills	33.4	28.7	23.2	20.0	19.1	17.0	14.4	13.5	12.8	12.7	12.7	12.7
Unconventional Sources	3.6	5.5	6.1	6.0	5.6	5.0	4.6	3.6	3.5	3.5	3.5	3.5
Subtotal	37.0	34.2	29.3	26.0	24.7	22.0	19.0	17.1	16.3	16.2	16.2	16.2
UNDER CONSTRUCTION	-0-	0.3	2.0	2.5	2.7	3.0	3.0	3.0	2.8	2.8	2.8	2.8
TOTAL (rounded to nearest million)	37	35	31	29	27	25	22	20	19	19	19	19

Table 8
ESTIMATED WORLD URANIUM PRODUCTION[1]
(millions of pounds U_3O_8)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Australia	1.8	2.3	3.8	4.3	6.9	9.3	9.1	9.1	9.1	9.1	9.1	9.1
Canada	17.5	19.0	20.9	21.6	21.6	23.1	24.6	24.6	24.6	24.6	24.6	24.6
Republic of South Africa	12.5	15.1	18.5	19.4	20.2	20.7	21.1	21.5	21.5	21.5	21.5	21.5
Other Africa	21.8	23.7	26.8	27.8	29.6	31.6	31.6	31.6	31.6	31.6	31.6	31.6
Other Nations[2]	7.9	9.2	11.1	11.6	11.9	11.9	12.4	14.0	14.0	14.0	14.0	14.0
Non-US Total[3] (rounded to nearest million)	62	69	81	85	90	97	99	101	101	101	101	101
US[4]	37	35	31	29	27	25	22	20	19	19	19	19
Total	99	104	112	114	117	122	121	121	120	120	120	120

[1] Outside Communist Area.
[2] Includes Argentina, Brazil, France, Mexico, Spain and others, but does not include Communist areas.
[3] Nuexco Report 141, Table 5.
[4] This Report, Table 7.

Table 9
ESTIMATED WORLD URANIUM PRODUCTION[1]
(millions of pounds U_3O_8)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
OPERATING												
US	37.0	34.2	29.3	26.0	24.7	22.0	19.0	17.1	16.3	16.2	16.2	16.2
Non-US	61.5	69.1	76.5	78.3	80.1	82.1	82.1	83.0	82.9	82.8	82.8	82.8
Subtotal	98.5	103.3	105.8	104.3	104.8	104.1	101.1	100.1	99.2	99.0	99.0	99.0
UNDER CONSTRUCTION												
US	-0-	0.3	2.0	2.5	2.7	3.0	3.0	3.0	2.8	2.8	2.8	2.8
Non-US	-0-	0.3	4.4	6.4	10.2	14.7	16.8	17.8	17.8	17.8	17.8	17.8
Subtotal	-0-	0.6	6.4	8.9	12.9	17.7	19.8	20.8	20.6	20.6	20.6	20.6
TOTAL[2]	99	104	112	114	117	122	121	121	120	120	120	120

[1] Outside Communist Areas.
[2] Rounded to nearest million.

Table 10

NON-AUSTRALIAN PARTICIPATION IN ENERGY RESOURCES OF AUSTRALIA (ERA)

	Percentage Ownership of ERA	Approximate Annual Quantity (millions of pounds U_3O_8)	Approximate Total Quantity, 1982-1996 (millions of pounds U_3O_8)
UTILITIES			
RWE	6.51	1.30	17.7
Kansai	5.21	1.04	14.2
Kyushu	2.60	0.52	7.1
Shikoku	1.56	0.31	4.3
OTHERS			
Urangesellschaft	4.17	0.84	11.3
Saarberg-Interplan	3.91	0.78	10.6
C. Itoh	1.04	0.21	2.8
TOTALS	25	5.0	68.0

and mill complex, the marketing of most of the output, and the public float of part of ERA's equity to the Australian public. The breakdown of ERA ownership will be:

Peko Wallsend	30.5%
EZ Industries	30.5%
German interests	14.6%
Japanese interests	10.4%
Public ownership	14%
	100%

Of particular interest is the fact that almost two million pounds annually has been committed to non-end users which, so far as is presently known, have yet to include firm agreements for resale of this tonnage. The policy of the Australian government in this regard has shifted, for whereas such resale was formerly a precondition to equity participation, it has been learned that this position has been eased to require only that such approved resale agreements be in effect prior to export of the material.

The government indicated in its announcement that the sales were in accordance with Australian guidelines, i.e. firm take and pay arrangements with floor and market price provisions. If so, it must be assumed that the purchasers which are not end-users elected to take the market risk in a time of considerable price uncertainty. Such risk-taking would appear to be most unlikely, which raises the question of what, if any, mechanism exists in the contracts to provide the buyers with relief in the event that the floor price exceeds market.

CANADA

There has been considerable speculation in the industry regarding policy considerations connected with the Rio Algom (formerly Preston) and Denison contracts with Ontario Hydro. These contracts received final approval in 1978 and, at the time they were signed, the industry was reminded that the Canadian Government had a policy that uranium exports from Canada would not normally be approved at prices or terms and conditions more favorable than those available to Canadian utilities.

The question that is now being debated is, given the situation where these large (198 million pounds), long term (final deliveries in the year 2020) contracts are in effect at prices that are by now almost certainly higher than current spot market prices, what will be the reaction of the Canadian Government to the granting of new export permits. The answer appears to be that the Canadian government policy is being interpreted in a contemporaneous manner. That is, at any given point in time, the government's policy is that there should not be a substantial mismatch between terms and conditions being offered internationally versus those being offered domestically. Thus, the older sales to Ontario Hydro do not necessarily establish a pricing floor for new exports.

Separately, the Rio Algom and Denison agreements with Ontario Hydro are now "under review" at the provincial level and will probably be the subject of provincial hearings near the end of the year.

The Cluff Lake production center in northern Saskatchewan is nearing completion and should begin production in early 1981. The deposit is owned 80 percent by Amok, Ltd. and 20 percent by Saskatchewan Mining Development Corporation. Proven ore reserves total about 50 million pounds U_3O_8. The initial annual production rate is expected to be 2.6 million pounds U_3O_8.

Figure 1 is an aerial view of the Cluff Lake site. Figure 2 is a close-up photograph showing the covered ore stockpiles in the foreground, with the metallurgical plant in the background.

EUROPE

The amount of electricity produced by nuclear power in the European Economic Community increased in the first quarter of 1980 by about 21 percent, compared to the first quarter of 1979. This was due in large part to new plants coming on line in France, where nuclear generation increased more than 50 percent between first quarter, 1979 and first quarter, 1980.

The French nuclear program continues to progress. During July, 1980, the French reactors Gravelines unit 1 and Tricastin unit 1 both reached full power operation for the first time. Also during July, Tricastin unit 2 achieved its first criticality, and in early August Gravelines unit 2 reached initial criticality.

FAR EAST

The equity participation of **Japan** in Australia's Ranger project had been announced (see Australia section of this Report). Prior to this announcement, approximate distribution of sources of uranium under contract to Japanese utilities was as follows:

Canada	40%
South Africa	40%
Australia	10%
Other (US, Niger, France)	10%

This purchase of over 28 million additional pounds from Australia will alter the geographical balance, reducing current dependence on Canada and South Africa and increasing security of overall supply through diversity. The Ranger purchase will change the balance as follows:

Canada	36%
South Africa	36%
Australia	19%
Other	9%

UNITED STATES

The US Nuclear Regulatory Commission voted to authorize Virginia Electric and Power Company to operate its North Anna unit 2 reactor at full power. This marks the first such license issued since the Three Mile Island accident.

The average price of uranium paid by US utilities for 1979 delivery, as compiled by USDOE, was \$23.85. This was up from \$21.60 in 1978, and \$19.75 in 1977.

On July 31, 1980, USDOE announced an increase in the price of uranium enrichment services. Separative work performed under Fixed-Commitment contracts will be increased from \$98.95 per SWU to \$110 per SWU. The effective dates of the change will be September 30, 1980 (60 days notice), in the case of Long-Term Fixed-Commitment contracts, and November 29, 1980 (120 days notice) in the case of Adjustable Fixed-Commitment contracts.

The charge under Requirements-type contracts will also be increased from \$110.75 or the formula ceiling price (presently estimated at \$105.54 per SWU), whichever is lower, to \$119.00 or the formula ceiling price, whichever is lower. The effective date of this change will be January 28, 1981 (180 days notice).

The nuclear platform planks of both the Republican and Democratic Parties contain endorsements of the continuation of nuclear power in the US, although in different degrees. The Republicans enthusiastically call for "accelerated use of nuclear energy through technologies that have been proven efficient and safe." However, the Democrats, facing a strong antinuclear lobby seeking a full nuclear moratorium, promise to "retire nuclear plants in an orderly manner" as alternate forms of energy become available.

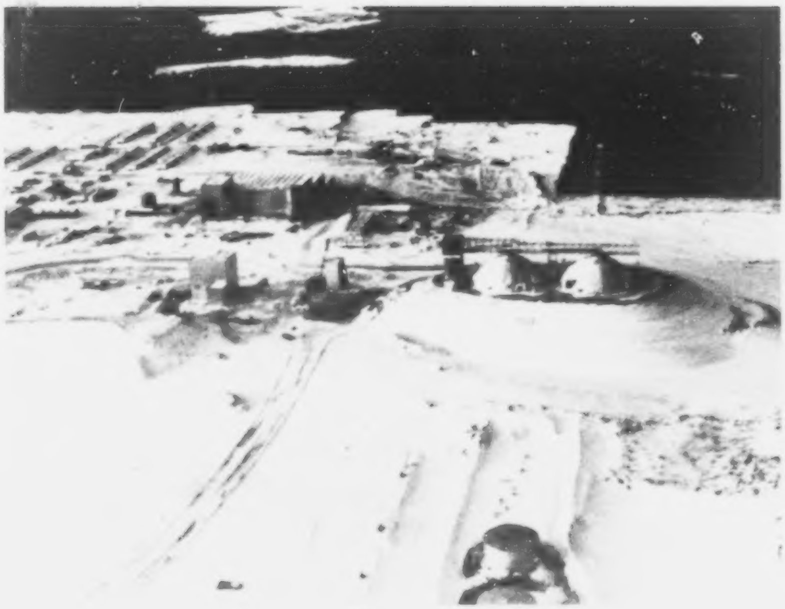


Figure 1
AERIAL VIEW OF THE CLUFF LAKE SITE IN NORTHERN SASKATCHEWAN

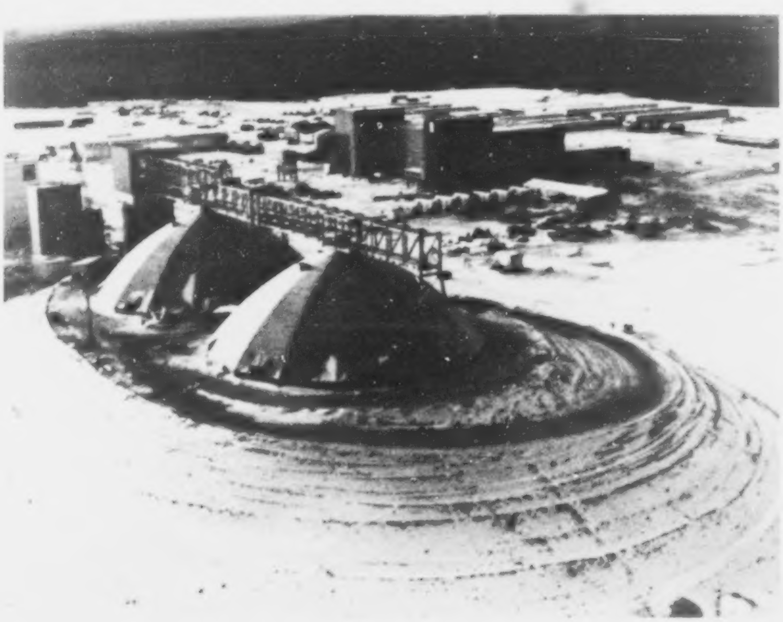


Figure 2
CLOSE-UP OF THE CLUFF LAKE MILL. THE ORE STOCKPILES ARE IN THE FOREGROUND. THE METALLURGICAL PLANT IS IN THE BACKGROUND.

URANIUM MARKET

Kerr-McGee Nuclear Corporation has announced the closing of two uranium mines at Ambrosia Lake, New Mexico. Also, operations at Anaconda's Jackpile uranium mine in New Mexico will be phased out by the end of the year. Rising costs and projected future uranium prices were cited as reasons for the closings.

TRANSACTIONS

Ten transactions were concluded this month in addition to the series of transactions associated with the establishment Energy Resources of Australia (see Australia section). Nine of the ten transactions were for spot and near-term delivery. One large sale was between a Canadian producer and a US utility for between 600,000 and one million pounds of U_3O_8. Another US utility purchased two small quantities of material from two US producers. One of the deals was for less than 50,000 pounds, the other for under 100,000 pounds. A European firm sold less than 50,000 pounds to a Japanese trading company with delivery to occur in 1981. A US producer sold less than 50,000 pounds to a US utility, with deliveries extending into 1981. A US producer sold a small quantity to a Far East government entity.

There were three transactions this month involving US utilities as sellers. In one transaction, a US nuclear contractor purchased between 100,000 and 300,000 pounds U_3O_8. In the second, a US producer purchased between 50,000 and 100,000 pounds. In the third, a European utility purchased between 100,000 and 300,000 pounds U_3O_8.

Finally, Queensland Mines, Ltd. of Australia announced the sale of 1.8 million pounds U_3O_8 to TVO of Finland. Delivery is scheduled for 1981 through 1989.

PRICING

The price decline in the first part of 1980 was caused, at least partially, by utilities' selling inventory due to the high interest rates. As prices dropped, and interest rates lowered, pressure by utilities to sell inventory eased somewhat. Thus the market has remained in a metastable condition over the past few months. Now, however, several buyers have emerged attempting to secure favorable prices on intermediate and long term uranium supply contracts. In response to these inquiries, uranium producers have begun active price competition in order to sell material for all delivery schedules, spot through long-term.

In competing for this business, most US producers are trying to cover higher production costs by seeking escalated floor prices or other contract provisions aimed at avoiding selling at a loss. Some non-US producers, however, are offering terms which reflect their much lower production costs. Because of this, non-US producers are beginning to capture a larger share of the US market, at price levels where few, if any, US producers can effectively compete. This applies to the spot and near-term markets as well as the longer term.

Continued competition in the US market from non-US producers may have a significant effect on US production. US producers face difficult decisions at this time on how to respond to active inquiries from utilities, especially when these buyers may not re-enter the uranium market for another decade. It now appears, however, that non-US producers are taking advantage of the current opportunities to become market leaders in the US.

The **Exchange Value** decrease to \$30.00 per pound U_3O_8 this month, down from \$31.50 last month. The decline is due mainly to active competition among non-US producers, although a few inventory holders are making renewed efforts to sell.

The **Transaction Value** decreased to \$31.60 per pound U_3O_8. Several transactions closed this month, thus making it possible to drop from the sample the large number of transactions which were reported in Report 139, when spot prices were higher.

CONVERSION

As indicated in the *Market Opportunities* section of this Report, the amount of conversion services currently being offered for sale in the secondary market is very large. At the same time, there is essentially no demand for spot conversion. There remains substantial depth in the market to sell conversion at about \$1.50 per pound U as UF_6. However, the extreme excess of supply in this market will likely put downward pressure on offered prices in the near future.

TOPICAL ESSAY

HISTORICAL PERSPECTIVE ON US URANIUM PRODUCTION

The supply and demand balance discussed in the *General* section of this Report indicates that the world uranium market is in an oversupply condition, which will probably continue for some time. This situation would indicate the continuation of a relatively strong buyers' market. Because the US uranium industry is a high cost industry relative to the other major uranium producing countries, it is expected that US production will tend to decrease. Competition from non-US production, as well as the effect of the large and growing US utility inventory position, is mainly responsible for the projection by Nuexco of declining US production levels over the next few years.

US uranium production in 1980 will probably be nearly double US consumption. (See Table 2, above.) In fact, production of uranium in the US has been greater than US power reactor consumption in every year of the existence of the commercial nuclear program. However the present imbalance is being exacerbated by the many long-term supply contracts currently in existence. Deliveries under these contracts are pumping much unneeded uranium into users' inventories.

The major driving forces leading to this result developed years ago. Anticipated uranium shortages combined with the implementation of the long-term fixed-commitment enrichment contract prompted users to sign long-term uranium contracts. More recently, reactor schedule slippages and cancellations, combined with relaxation of enrichment contracts by USDOE have resulted in many utilities' taking delivery of unneeded uranium. The buildup of excess inventory will probably lead to overcorrection in the long run, in the form of weak demand and resultant declining supply. While existing supply contracts can be expected to underpin US production over the next few years, their effect will be attenuated somewhat as some producers choose to purchase material on the spot market rather than produce it themselves.

A revised Nuexco forecast of US uranium production is tabulated in Table 7 of this Report. The forecast is based on Nuexco's assessment of the individual situation of each producer or potential producer in response to the current and expected market climate. The conclusion is that US uranium production probably reached its maximum in the 1978-79 period, and will likely fall over the next few years.

It is interesting to compare today's market situation with similar situations in the history of the US uranium industry. Figures 3 and 4 were prepared to provide a basis for determining if past experience would help assess the potential extent and rate of change in US production in response to today's market.

Figure 3 contains a plot of total US uranium production for the years 1950 through 1979. Also plotted in Figure 3 are three indicators of uranium price over the years: the annual average price paid by the USAEC for US uranium during its procurement program, the annual average Nuexco Exchange Value, and the annual average price paid by US utilities, as compiled by the USDOE. All of the prices plotted in Figure 3 are in First Quarter 1980 dollars, adjusted for inflation by the GNP Implicit Price Deflator published by the US Department of Commerce.

Figure 3 was prepared only to serve as an intermediate step. The data plotted in Figure 3 omit a very important factor, namely cost of production. In an effort to take this factor into account, Figure 4 was developed. Figure 4 contains the same plot of US production as Figure 3. The same three price indicators plotted in Figure 3 are plotted in Figure 4, after having been adjusted for changes in grade of ore over the years. That is, all price data in Figure 4 were adjusted to the 1979 US average grade of ore by multiplying by the ratio of US average ore grade in the year in question to US average ore grade in 1979. Grade of ore is generally the most sensitive variable in cost of production in the mining industry. Average US ore grade was about 0.30 percent U_3O_8 in the early 1950's, and has fallen steadily to about 0.11 percent in 1979. Adjusting the price indicators both to today's dollars and to today's grade of ore should yield a rough figure of merit on *relative* profitability in the uranium industry over the years, since it would take into account changes in dollar prices, changes in production cost, and inflation. For convenience, the data used in developing Figures 3 and 4 are tabulated in Table 11.

Some interesting conclusions can be deduced from Figure 4:

1. US uranium producers' profitability fell steadily from the early 1950's through the early 1970's. The fall is exaggerated somewhat by the fact that early uranium production centers were depreciated

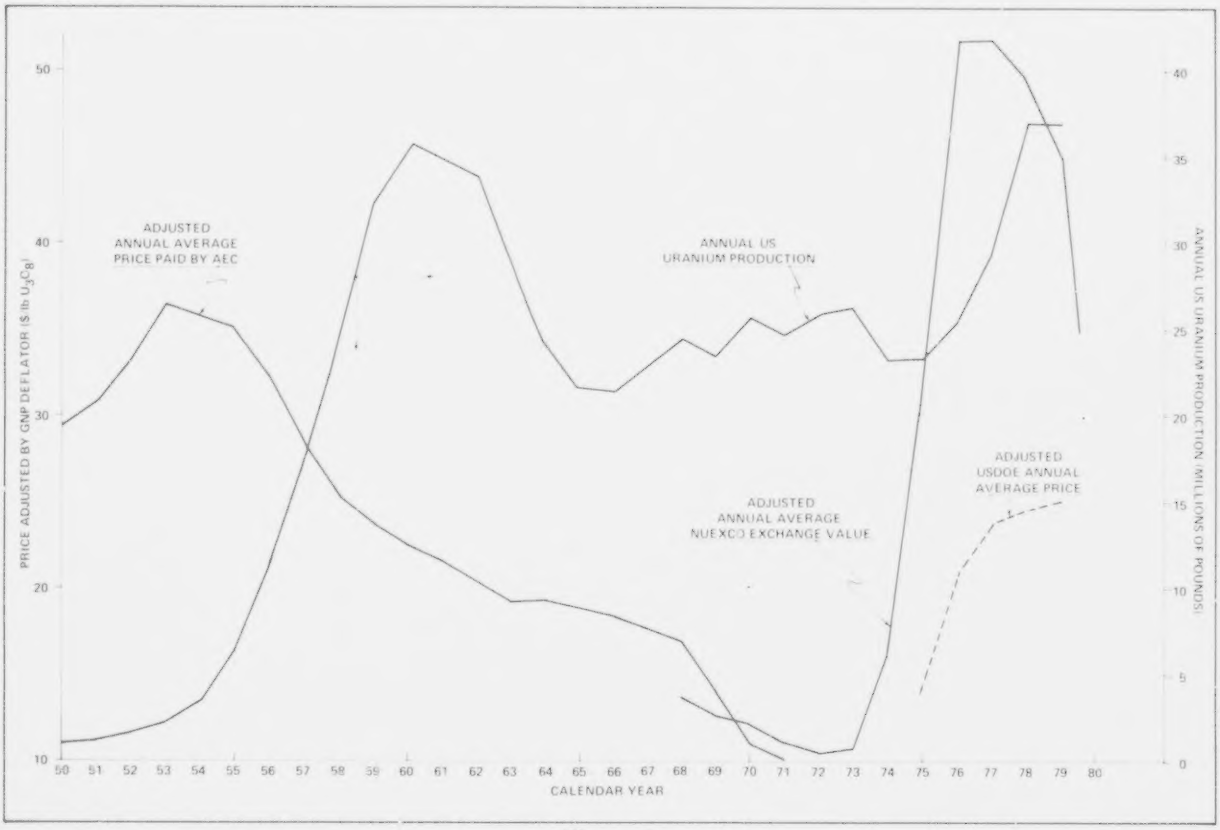


Figure 3
RELATIONSHIP BETWEEN US PRODUCTION AND THE CONSTANT DOLLAR PRICE OF URANIUM

quickly. Thus relative profitability was probably somewhat lower in the early years.

2. Steadily decreasing profitability apparently led to a peaking and falloff of production in the early 1960's.
3. Relative profitability did not change much on an *average* basis from the mid 1960's to the present time. The adjusted average USAEC prices in the mid to late 1960's and the adjusted average USDOE prices for recent years are roughly comparable.
4. Increasing spot prices in the mid 1970's brought about an expected (and, in some cases, a realized) increase in profitability which resulted in the expansion of US production to an annual level of about 37 million pounds U_3O_8.
5. At present there is a large gap between production level and relative profitability.

In fact, today's relative profitability, measured either by the current Exchange Value or the most recent USDOE average price, is very low. On the other hand, the US production was at its highest level as of 1979. This implies that US production will very likely fall off in the future if current price trends and production cost trends continue. The rate of decline will probably be relatively steep because, in addition to other economic pressures, many US producers are expected to purchase part of their existing delivery commitments, rather than produce the material themselves.

The logical conclusion is that, unless the *real* price of uranium increases substantially, US production will drop, and the US will soon need to import substantial quantities of uranium. It is important to recognize, however, that this need to import will be the result of economics and not the result of lack of uranium resources. Thus the situation in the uranium industry is not immediately comparable to that in the petroleum industry. However, discovery of low-cost deposits in the US of a type comparable to those of Australia and Canada would alter the situation considerably.

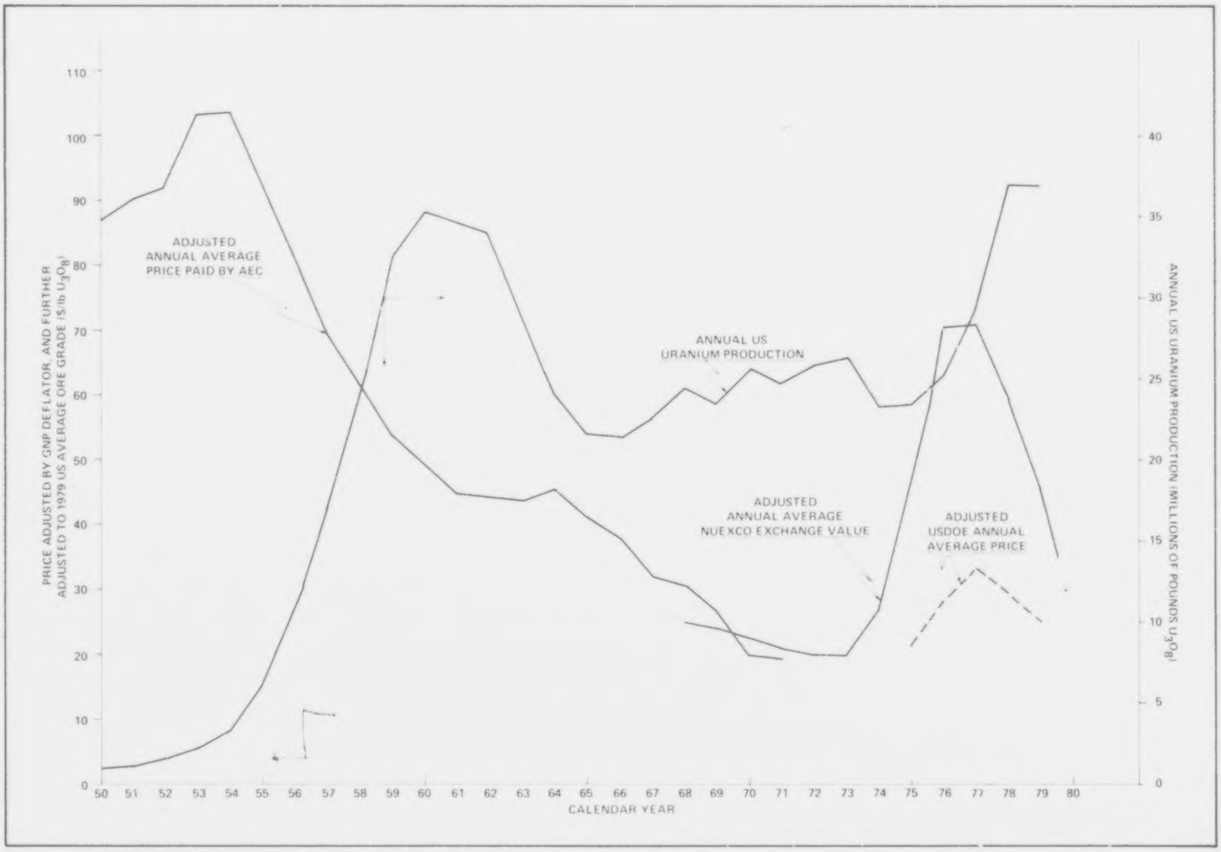


Figure 4
RELATIONSHIP BETWEEN US PRODUCTION AND THE RELATIVE PROFITABILITY OF THE US URANIUM INDUSTRY

Table 11
DATA USED TO DEVELOP FIGURES 3 AND 4 OF THIS REPORT

Year	USAEC Annual Average Price Paid[1] [2]	NUEXCO Average Annual Exchange Value	USDOE Annual Average Price Paid[3] by US Utilities	GNP Implicit Price Deflator[4] (1972 = 100)	Annual Average US Grade of Ore[1] (percent U_3O_8)
1950	9.11			53.64	0.32
1951	10.10			57.27	0.32
1953	12.35			58.88	0.31
1954	12.27			59.69	0.32
1955	12.25			60.98	0.29
1956	11.51			62.90	0.28
1957	10.49			65.02	0.27
1958	9.45			66.06	0.27
1959	9.12			67.52	0.25
1960	8.75			68.67	0.24
1961	8.50			69.28	0.23
1952	8.15			69.28	0.23
1962	8.15			70.55	0.24
1953	7.82			71.59	0.25
1964	8.00			72.71	0.26
1966	8.00			76.76	0.23
1967	8.00			79.02	0.20
1968	8.00	6.40		82.57	0.20
1969	6.99	6.20		86.72	0.21
1970	5.74	6.25		91.36	0.20
1971	5.54	6.06		96.02	0.21
1972		5.95		100.00	0.21
1973		6.40		105.80	0.21
1974		11.00		116.02	0.18
1975		23.70	10.50	127.18	0.16
1976		39.70	16.10	133.88	0.15
1977		42.20	19.75	141.61	0.15
1978		43.25	21.60	152.05	0.13
1979		42.60	23.85	165.46	0.11
1980		33.75[5]		174.51[6]	

[1] Statistical Data of the Uranium Industry; January 1, 1980; GJO-100(80).
[2] Data is for fiscal year indicated.
[3] Survey of United States Uranium Marketing Activity; August 1979; DOE RA-0038.
[4] US Department of Commerce, Washington, D.C.; Bureau of Economic Analysis "Survey of Current Business."
[5] First eight months.
[6] First quarter.

RAW MATERIALS

URANIUM IN ARGENTINA

Introduction

In the late 1940's the government of Argentina began to consider the country's future energy requireents and how it could achieve energy self-sufficiency by the year 1985. One basic conclusion at the time was that the country's energy base would have to be broadened greatly from a high dependence on oil and gas to a greater percentage of coal and hydro, and the new energy source, nuclear power. With that decision, the government began to evaluate the potential for uranium resources in Argentina.

A preliminary evaluation program was sanctioned for the area of crystalline rocks in the Cordoba and San Luis Mountains as early as 1946, resulting in the discovery of uranium-bearing quartz veins. Encouraged by this, the government formed the National Atomic Energy Directorate, to coordinate the total evaluation effort. Metamorphic rocks in the mountainous areas were included in the evaluation program.

The apparent success of the early resource evaluation program was a factor in the government's decision to begin a nuclear power generating program with an initial target capability of 3300 Mwe. The plan called for six generating units—the first of which began operating in 1974. The second unit is scheduled to be on line in 1982.

The final government decision to proceed with the nuclear program was based in part upon a predetermined conclusion that all uranium requirements could be supplied from indigenous sources. All evaluation activity was consolidated under one government agency, the Comision National de la Energia Atomica (CNEA), in 1956 to expedite the program. The success of the program is indicated by the fact that uranium resources recoverable at US $50 or less per pound U_3O_8, are estimated at 28,000 tonnes U_3O_8.

The CNEA has a continuing exploration program to search for additional uranium resources. For the first time, foreign groups are now allowed to explore for uranium if they can demonstrate technical and financial capabilities to the CNEA. A participating group can earn a 50 percent interest in a uranium deposit, of which 25 percent of the mined product can be sold; the remaining 25 percent must be sold to the CNEA.

Geology

Uranium mineralization is known to occur in a variety of different rock-types throughout Argentina, primarily in the provinces of Jujuy, Salta, La Rioja, Cordoba, Catamaca, Mendoza, Neuquen and Chubut. Geologically, the main areas of interest are the Jurassic and Cretaceous sediments in Mendoza Province, and the Cretaceous and Tertiary sediments in Jujuy and Salta Provinces. The sediments are considered to offer the greatest potential for large uranium resources, even though numerous important occurrences have been discovered in other rock types. Figure 5 shows the location of uranium deposits, mines, and milling facilities throughout Argentina.

Mineralization has been found in Precambrian crystalline rocks and metamorphosed slates in the mountains of Cordoba. The ore minerals show dispersion throughout the coarse-crystalline segment of the intrusive rocks, and often in localized high-grade concentrations along formation contact zones. Small tonnages of high-grade ore have also been found associated with columbite in pegmatite dikes which occur in the same crystalline rocks.

In the Comachingones district of southern Cordoba province, uranium and fluorite occur together in porphyritic granite and metamorphic contact rocks. Uranium and thorium mineralization are found as fracture fillings in Precambrian granites and metamorphics in Jujuy and Salta provinces, primarily in the Jujena district and the area of Sierra de Rangel. In the San Isidro district of Mendoza, uranium mineralization occurs in a highly brecciated zone within Triassic sedminets, and lightly scattered throughout Carboniferous and Permian granites. Uranium-bearing quartz veins are rather common to most of the described rock types.

All the above occurrences are considered to be of hydrothermal origin—that is, mineralization was precipitated from ascending hot aqueous solutions. The origin of the mineral-bearing solutions was probably associated with deep-seated igneous activity, however precipitation of the mineral probably occurred during a later geologic period.

Generally, the hydrothermal uranium occurrences of Argentina contain only a limited amount of recoverable uranium. Estimated ore reserves are low and past production has been insignificant. However, evaluation of geologically favorable intrusive and metamorphic rocks continues. The geology is favorable for the occurrence of either a large disseminated occurrence in granitic rocks, similar to the Rossing

RAW MATERIALS

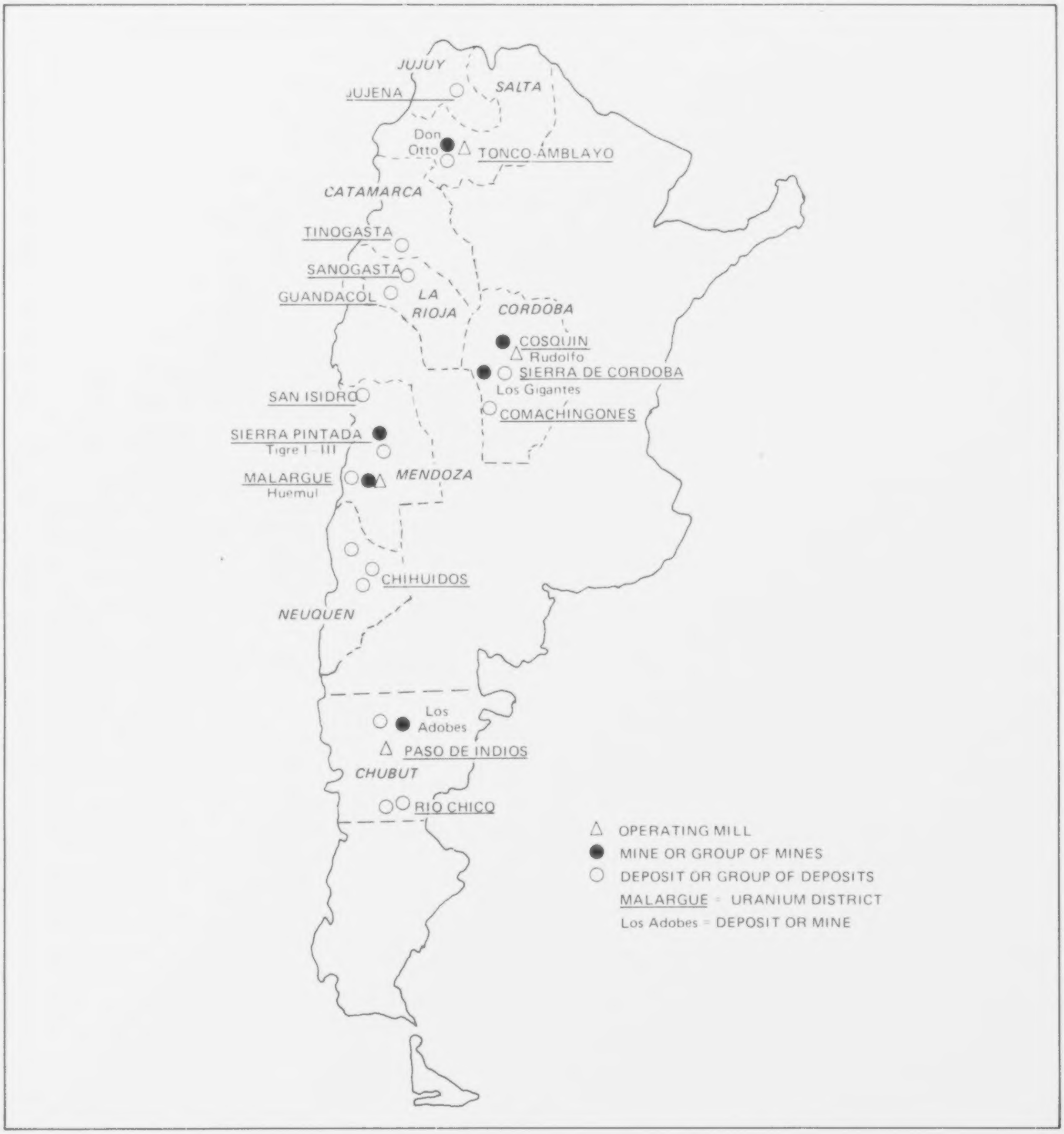

JUJUY
SALTA
JUJENA
Don Otto
TONCO-AMBLAYO
CATAMARCA
TINOGASTA
SANOGASTA
GUANDACOL
LA RIOJA
CORDOBA
COSQUIN
Rudolfo
SIERRA DE CORDOBA
Los Gigantes
COMACHINGONES
SAN ISIDRO
SIERRA PINTADA
Tigre I - III
MALARGUE
Huemul
MENDOZA
CHIHUIDOS
NEUQUEN
Los Adobes
PASO DE INDIOS
CHUBUT
RIO CHICO
△ OPERATING MILL
● MINE OR GROUP OF MINES
○ DEPOSIT OR GROUP OF DEPOSITS
MALARGUE = URANIUM DISTRICT
Los Adobes = DEPOSIT OR MINE

Figure 5
MAP OF ARGENTINA SHOWING EACH PROVINCE WITH URANIUM DEPOSITS, MINES & MILLS

deposit in Namibia, or a large, high-grade vein deposit in metamorphic rocks, such as the Schwartzwalder deposit in the Colorado Front Range of the US.

Mineral Deposits

The greatest number of known uranium occurrences in Argentina are found in sandstone formations. The most important deposits are in Permian and Cretaceous formations. Mineralization and small ore deposits are known to occur in sediments of Upper Paleozoic, Mesozoic and Tertiary formations.

The *Sierra Pintada* district of Mendoza Province is probably the largest in the country. There are at least 12 deposits in the Sierra Pintada district that are presently of economic interest. The main zone of mineralization usually occurs in the Atigrades Sandstone Member of the Los Reyunos Formation. The sand unit shows cross-bedding with conglomeratic stringers common to the lower bottomset beds; mudstone lenses are present, but are less common than the conglomerates.

The sandstone member is 70 to 80 meters thick with a thin marker bed of tuffite near the middle. Uranium mineralization occurs primarily in the sand unit above the tuffite, but important concentrations occur below it as well. The ore zones vary in thickness from 2 to 12 meters; the ore grade ranges from 0.05 to 0.15 percent U_3O_8. The main ore minerals are uraninite, brannerite and coffinite—all primary minerals. The secondary mineral uranophane has been identified in altered rock near the top of the deposit. It occurs as then coatings along joints and fault planes in the sandstone.

Most known deposits in the Sierra Pintada district have been displaced by faulting which followed mineral deposition. For example, the largest deposit, the Tigre I, is divided into three separate ore blocks by two parallel, east-west faults. The south ore block has been displaced downward 80 to 120 meters lower than the north block. A number of smaller north-south faults have further broken up each ore block. The pitch of the ore zones varies from about 12 degrees southward on the north block to as much as 30 degrees southward on the south block.

The ore genesis proposed for the district is based upon a process of leaching uranium from younger acid volcanics which once covered the entire Sierra Pintada region. Precipitation of the uranium from the ground water and into the Atigradas Sandstone followed, forming typical peneconcordant-type deposits similar in occurrence to the deposits in the Grants uranium belt of New Mexico.

The ore reserves at the Tigre I deposit were upgraded in 1978. According to the last estimate of recoverable reserves, the deposit contains about 15,200 tonnes U_3O_8. This represents the largest known uranium deposit in Argentina. Other important deposits in the Sierra Pintada district include the Tigre II & III and the Media Luna I, II and III, located one to two kilometers south of Tigre I. The geology of the latter deposits is similar to Tigre I.

The *Malargue* district is probably the second most important uranium district in Argentina. It is situated about 40 kilometers south of the village of Malargue in Mendoza Province. Uranium deposits of the district occur in the Diamantian Formation of Upper Cretacous Age. The formation consists of a thick arkosic sandstone and conglomerate series with interbedded clay and sandstone stringers. Andesite dikes of Tertiary Age have intruded the Diamantian Formation causing intense fracturing at the contact. Also fragments of carbonaceous material occur throughout the formation, showing greater concentration at, or near, gradational contacts with the clay and sandstone. Formation thickness varies from about 800 to 1100 meters in a south to north direction.

Uranium mineralization in the Malargue district also occurs in conjunction with copper. Uranium was first identified in the district in copper ores from the Cerro Mirano mine in 1952. The CNEA began prospecting the area, and within a short time, over twenty uranium occurrences had been found in the Diamantian Formation. Both uranium and copper mineralization are concentrated in bedded deposits at several different stratigraphic horizons, usually within the lower third of the formation.

The upper portions of the ore deposits are usually oxidized. The uranium and copper mineralization in the upper portions consists of secondary minerals. The uranium minerals are carnotite, tyuyamunite and autunite. Carnotite is the predominant mineral and it occurs as high-grade stringers in fractures and as a coating around the conglomerate matrix. Tyuyamunite and autunite are much less prominant and are not important as ore minerals. The unoxidized lower portions of the ore deposits contain primary minerals of uranium and copper. Uraninite is the principal uranium mineral. The mineral thucholite, a complex mineral containing uraninite, hydrocarbons and thorium, is common in some deposits, but it is not important as an ore mineral.

The important deposits within the Malargue district include Huemul, Agua Botada, Pamap Amarilla and Cerro Mirano. There is little information on reserves or the status mining in the district. A processing mill is operating in the area at an annual capacity of about 50 tonnes U_3O_8.

The *Chihuidos de Medio* district in Neuquen Province is now being actively explored. Uranium has been found in smali deposits in the Diamantian Formation. The geologic setting is comparable to the Malargue district. Uranium discoveries there have been less important than in other areas.

Numerous uranium occurrences have been discovered in the *Tonco-Amblayo* district in Salta Province and the *Jujena* district in Jujuy Province. The host rock is silt, mudstone, sandstone and sandy-limestone of the Salta Formation of Upper Cretaceous Age. The uranium mineralization is considered to be epigenetic, being leached from Precambrian intrusives and metamorphic rocks, and precipitated in the Salta Formation. In addition, uranium mineralization is known to occur in sedients of Upper Pliocene (Tertiary) age.

Uranium occurrences in sandstone have been found in the provinces of Catamarca, Cordoba, La Rioja and Chubut. Host rocks vary in age from Triassic to Tertiary. Generally, the deposits are small and require additional evaluation. However, the Los Gigantes and Rudolfo deposits in the *Sierra de Cordoba* and *Cosquin* districts of Cordoba are being mined, or are under development, as is the Los Adobes deposit in the *Paso de Indios* district of Chubut Province.

Production Centers

Four processing plants, located in four different districts, are now in operation. (See Figure 5.) The Don Otto Mine and mill are located in the *Tonco-Amblayo* district of Salta Province. Mine production is about 60,000 tonnes of ore annually, all of which is processed at the nearby mill. Annual mill production has been about 30 tonnes U_3O_8. Rated mill capacity is about 50 tonnes U_3O_8 per year.

The mill in the *Cosquin* district of Cordoba Province produces about 25 tonnes U_3O_8 per year from ore supplied form the nearby Rudolfo mine.

Several deposits are being mined, or are now under development to supply the mill in the *Malargue* district. In addition, ore is mined at the Tigre I & III deposits in the *Sierra Pintada* district and trucked about 180 kilometers to the Malargue mill. Annual production of the Malargue mill is about 50 tonnes U_3O_8. It is probable that the mill will be expanded to an annual capacity of 365 tonnes U_3O_8 by 1983. Construction of a mill in the *Sierra Pintada* district is also a consideration, primarily to eliminate the long haul to Malargue.

In the *Paso de Indios* district of Chubut Province, mined ore from the Los Adobes deposit is being processed at the Pichinan milling complex. Annual production is about 35 tonnes U_3O_8. The mill might be expanded to provide milling capacity for the accelerated mining program now being considered.

Total annual production in Argentina is presently about 140 tonnes U_3O_8. Rated capacity is estimated at 180 tonnes U_3O_8. Most U_3O_8 production will probably be used in the Argentine nuclear power program, although a small amount was recently committed for export. U_3O_8 production has been steady since the late 1960's and Argentina currently enjoys a surplus of domestic U_3O_8.

STATISTICAL DATA

EXCHANGE VALUE—$30.00/lb U_3O_8
Determined as of August 31, 1980

Definition

The Exchange Value is Nuexco's judgment of the price at which transactions for significant quantities of natural uranium concentrates could be concluded as of the last day of the month.

Derivation

Nuexco bases the Exchange Value upon:

A. Data from recently completed transactions.
B. Data from pending transactions.
C. Firm bids to buy and firm offers to sell.
D. Prices purchasers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy, and prices sellers have expressed a willingness to accept, but for which Nuexco is not aware of firm offers to sell.

Comments

Nuexco does not consider the following in determining the Exchange Value:

A. The price of uranium delivered or to be delivered under old contracts.
B. The price of uranium delivered in connection with contract renegotiations or other than arm's length transactions.

TRANSACTION VALUE
Determined as of August 31, 1980

$/lb U_3O_8	Millions of Pounds	Number of Transactions	Number of Months
31.60	2.4	17	5

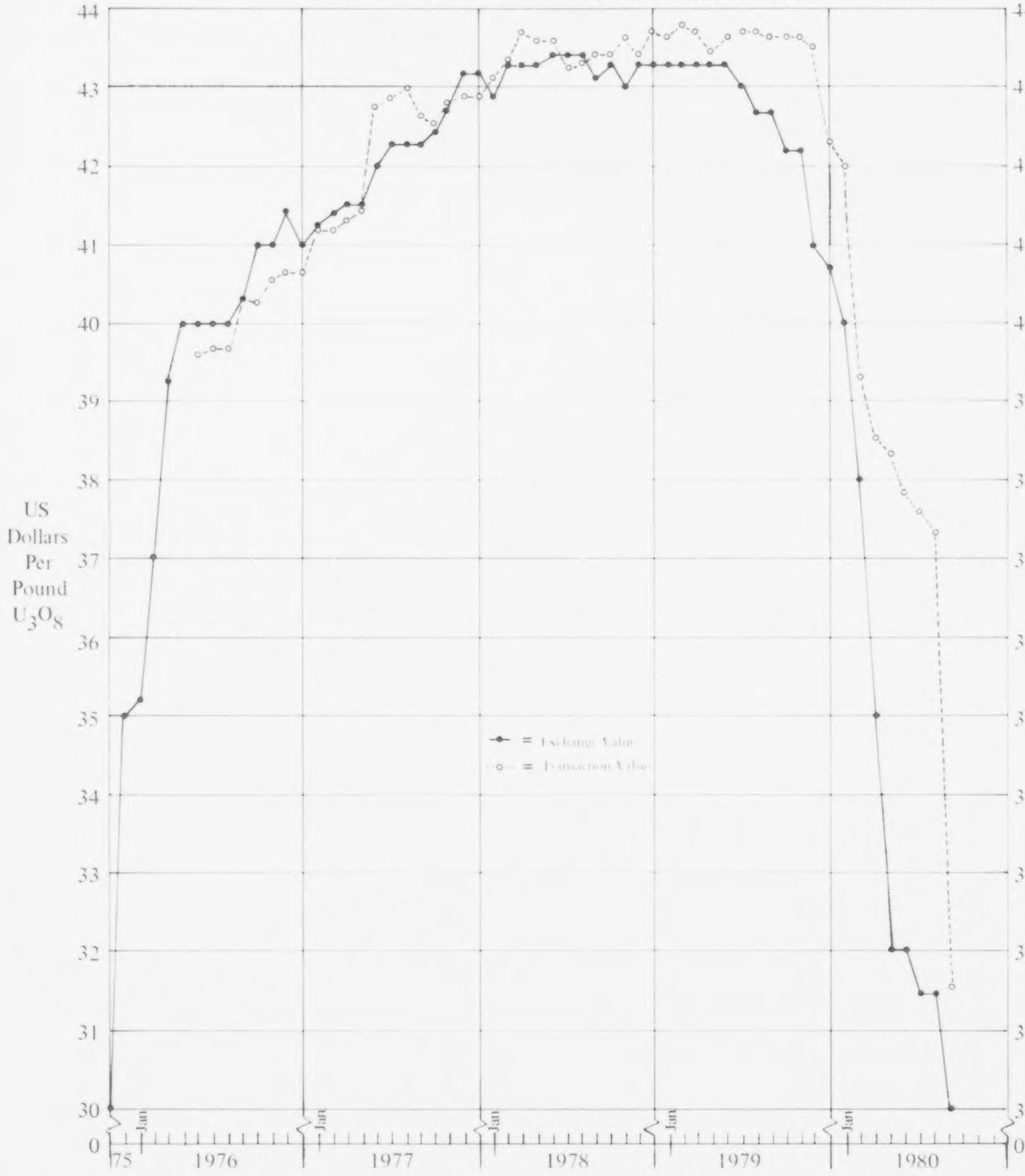
Definition

The Transaction Value is a weighted average price of recent transactions, and is based on prices paid for U_3O_8 in transactions closed within the previous three-month period and for which delivery was scheduled within one year of the transaction date. At least ten transactions totaling at least two million pounds U_3O_8 are included in each calculation, or the sample time is extended as necessary to include these minima. Foreign currencies are converted to US dollars as of the transaction date.

STATISTICAL DATA

EXCHANGE AND TRANSACTION VALUES SINCE NOVEMBER 1975

Determined as of the last day of the month indicated



STATISTICAL DATA

HISTORICAL EXCHANGE VALUES

Determined as of the last day of the month indicated
(US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1968	—	—	—	—	—	—	—	6.35	6.35	6.40	6.45	6.50
1969		6.35	6.10	6.10	6.25	6.25	6.20	6.20	6.15	6.15	6.15	6.20
1970	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.20	6.15	6.15	6.15	6.15
1971	6.20	6.20	6.20	6.20	6.15	6.05	6.00	5.95	5.95	5.95	5.95	5.95
1972	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95
1973	5.95	6.00	6.10	6.20	6.45	6.50	6.50	6.50	6.50	6.50	6.75	7.00
1974	7.70	7.90	8.00	9.00	9.50	10.50	11.50	12.00	12.50	14.00	14.75	15.00
1975	16.00	16.00	18.00	20.00	21.00	23.00	24.70	26.00	26.00	28.50	30.00	35.00
1976	35.20	37.00	39.25	40.00	40.00	40.00	40.00	40.40	41.00	41.00	41.50	41.00
1977	41.35	41.50	41.60	41.60	42.00	42.25	42.25	42.25	42.40	42.75	43.20	43.20
1978	42.90	43.25	43.25	43.25	43.40	43.40	43.40	43.10	43.25	43.00	43.25	43.25
1979	43.25	43.25	43.25	43.25	43.25	43.00	42.70	42.70	42.20	42.20	41.00	40.75
1980	40.00	38.00	35.00	32.00	32.00	31.50	31.50	30.00				

Note: See earlier Nuexco Reports for evolution of the definition of Exchange Value.

HISTORICAL TRANSACTION VALUES

Determined as of the last day of the month indicated
(US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1976	—	—	—	—	39.60	39.70	39.70	40.40	40.30	40.60	40.70	40.70
1977	41.30	41.30	41.40	41.50	42.80	42.90	43.00	42.60	42.50	42.80	42.90	42.90
1978	43.10	43.30	43.70	43.60	43.60	43.20	43.30	43.40	43.40	43.60	43.40	43.70
1979	43.60	43.80	43.70	43.40	43.60	43.70	43.70	43.60	43.60	43.60	43.50	42.30
1980	42.00	39.30	38.60	38.40	37.90	37.60	37.30	31.60				

Note: See Nuexco Report 135 for a discussion of the definition of Transaction Value.

STATISTICAL DATA

EXCHANGE VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES*

Country	per lb U_3O_8 in Concentrates	per kg U_3O_8 in Concentrates	per kg U in Concentrates
US (dollar)	30.00	66.14	77.99
France (franc)	124.74	275.00	324.30
FRG (mark)	53.64	118.25	139.45
Japan (yen)	6,543	14,425	17,011
Switzerland (franc)	49.37	108.83	128.34
UK (pound)	12.55	27.67	32.63
Australia (dollar)	25.82	56.92	67.12
Canada (dollar)	34.76	76.63	90.36
Niger, Gabon (CFA)	6,237	13,750	16,215
South Africa (rand)	22.68	49.99	58.95

*Calculated using currency exchange rates published in the Wall Street Journal on the last Friday of the month

LOAN USE CHARGE RATE—7.0% year

Definition

The Loan Use Charge Rate is Nuexco's judgment of the annual interest rate at which uranium loans could be concluded as of the last day of the month.

Derivation

Nuexco bases the Loan Use Charge Rate upon:

A. Data from recently completed or pending loan transactions.
B. Rates included in firm proposals to borrow or lend.
C. Rates that potential borrowers and lenders have expressed a willingness to pay or accept, but for which Nuexco is not aware of firm proposals.

STATISTICAL DATA

CURRENT TRANSACTIONS*

Nuexco Reference Number	Delivery Period	Approximate Quantity (thousands of pounds, U_3O_8 equivalent)	Approximate Price as percent of Current E.V.	Seller Group	Buyer Group	Remarks
1175	80	601 – 1000	101	Canada	US	
1179	80	1 – 50	100	US	US	
1180	80	51 – 100	99	US	US	
1183	81	1 – 50	<102	Europe	Far East	Exact price information not available
1186	80	101 – 300	103	US	US	
1187	80-81	51 – 100	101	US	US	
1189	80	101 – 300	107	US	Europe	
1190	80-81	1 – 50	102	US	US	
1191	81-89	1001 – 2000		Australia	Europe	Definitive price information not available
1192	80	1 – 50	108	US	Far East	

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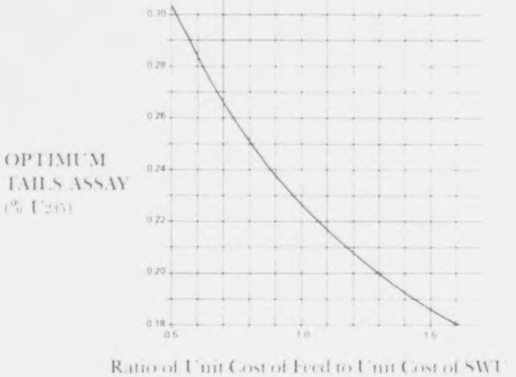
*Transactions listed include not only those in which Nuexco was involved, but also all others of which Nuexco is aware.

OPTIMUM TAILS ASSAY

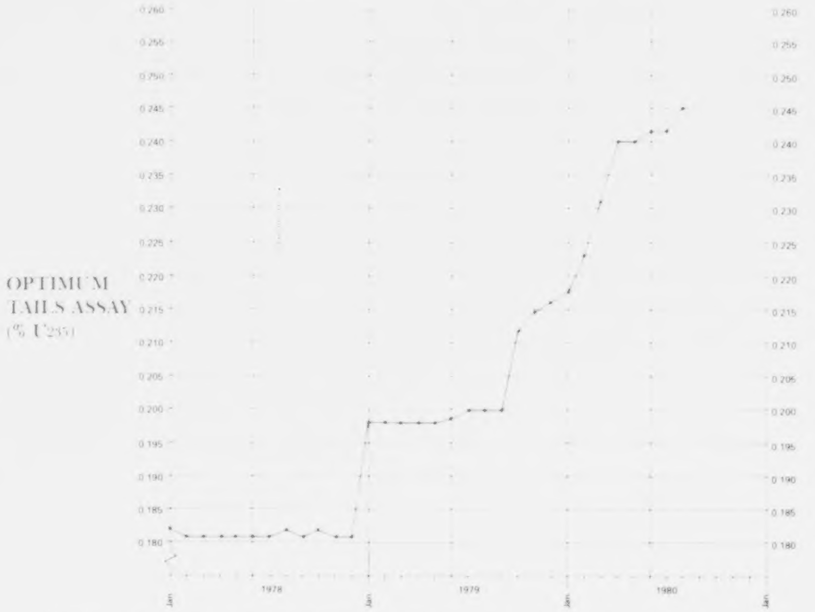
The optimum tails assay is the tails composition at which the cost of enriched uranium is lowest for given costs of separative work (SWU) and natural uranium feed. It depends only on the ratio of the cost of a kilogram of natural uranium in the form of UF$_6$ to the cost of a kilogram unit of separative work. The US Department of Energy (USDOE) Adjustable Fixed Commitment (AFC) enrichment contract holders have the option, within limits, to specify the transaction tails assay. The transaction tails assay for USDOE Requirements contracts is 0.2 percent U$_{235}$. For every one-hundredth of one percent increase in the transaction tails assay, uranium consumption increases about two percent.

TAILS ASSAY FOR MINIMUM COST OF PRODUCT*



*From Nuexco Report 138

HISTORICAL OPTIMUM TAILS ASSAY[1]



[1] Based on Exchange Value and USDOE AFC SWU price; interpolated to the nearest thousandth.

STATISTICAL DATA

US GOVERNMENT STATISTICS

	Producer Price Index—Industrial Commodities (1967 = 199)[1]	Consumer Price Index (1967 = 100)[2]	GNP Implicit Price Deflator (1972 = 100)[3]	Gross Average Hourly Earnings of Production or Non-supervisory Workers (US$)[4]		
				Metal Mining (SIC 10)	Primary Non-ferrous Metals (SIC 333)	Chemicals and Allied Products (SIC 28)
Annual Avg. 1970[5]	110.0	116.3	91.36	3.88	3.87	3.69
Annual Avg. 1971[5]	114.1	121.3	96.02	4.12	4.15	3.97
Annual Avg. 1972[5]	117.9	125.3	100.00	4.56	4.59	4.26
Annual Avg. 1973[5]	125.9	133.1	105.80	4.84	4.98	4.51
Annual Avg. 1974[5]	153.8	147.7	116.02	5.44	5.63	4.88
Annual Avg. 1975[5]	171.5	161.2	127.15	6.13	6.24	5.39
Annual Avg. 1976[5]	182.4	170.5	133.71	6.76	6.87	5.91
Annual Avg. 1977[5]	195.1	181.5	141.70	7.28	7.67	6.43
Annual Avg. 1978[5]	209.4	195.4	152.05	8.23	8.56	7.01
Annual Avg. 1979	236.5	217.4	165.46	9.27	9.50	7.59
May 1979	231.6	214.1		9.06	9.15	7.47
Jun 1979	234.0	216.6	163.81	9.09	9.44	7.53
Jul 1979	237.5	218.9		9.32	9.57	7.60
Aug 1979	240.6	221.1		9.38	9.70	7.65
Sep 1979	244.2	223.4	167.20	9.63	9.79	7.73
Oct 1979	249.0	225.4		9.67	9.87	7.82
Nov 1979	250.6	227.5		9.79	9.86	7.87
Dec 1979	253.1	229.9	170.58	9.80	9.92	7.91
Jan 1980	260.6	233.2		9.92	10.06	7.96
Feb 1980	265.4	236.4		9.93	10.01	7.99
Mar 1980	268.2	239.8	174.48	9.91	10.23	8.04
Apr 1980	270.7	242.5		10.00	10.30	8.12
May 1980	271.2P	244.9		10.18	10.37	8.17
Jun 1980	273.0P	247.6	178.93	10.21P	10.70P	8.22P
Jul 1980	275.6P	247.8		—		8.35P

P = Preliminary R = Revised since last month

(1) US Bureau of Labor Statistics, Washington, D.C.: "Producer Prices and Price Indexes," Table 6 (formerly "Wholesale Prices and Price Indexes"). Producer Price Indexes are revised four months after they are first released to reflect the availability of late reports and corrections by respondents.

(2) US Bureau of Labor Statistics, Washington, D.C.: Consumer Price Index for All Urban Consumers, US City Average, All Items.

(3) US Department of Commerce, Washington, D.C.; Bureau of Economic Analysis, National Income and Wealth Division: "Survey of Current Business," Table A. The GNP Implicit Price Deflator is published quarterly, and seasonally adjusted.

(4) US Bureau of Labor Statistics, Washington, DC.: "Employment and Earnings," Table C-2. All data based on 1972 revision of SIC Manual. Data for 1970-1976 are adjusted to the March 1977 benchmark. Data for January 1977 through March 1980 are adjusted to the March 1978 benchmark. Data for April 1980 and beyond are adjusted to the most recent benchmark—March 1979.

(5) Data for 1970-1978, monthly except for the GNP Implicit Price Deflator, appear on pages 4.6 through 4.8 of Nuexco Report 139.

AUSTRALIAN GOVERNMENT STATISTICS

	Price Index of Materials Used in Manufacturing Industry—All Groups (Year 1968-69 = 100.0)[1]	Weighted Average Minimum Weekly Wage Rates—Adult Males Australia Mining and Quarrying (A$)[2]
Annual Avg. 1970 (3)	101.4	59.88
Annual Avg. 1971 (3)	101.5	65.95
Annual Avg. 1972 (3)	105.6	71.26
Annual Avg. 1973 (3)	124.4	78.96
Annual Avg. 1974 (3)	141.9	108.07
Annual Avg. 1975 (3)	150.4	132.55
Annual Avg. 1976 (3)	168.4	160.93
Annual Avg. 1977 (3)	192.0	179.03
Annual Avg. 1978 (3)	215.4	190.04
Annual Avg. 1979	248.5	196.34
Mar 1979	264.0	191.64
Apr 1979	274.0	192.46
May 1979	288.5	193.56
Jun 1979	294.9	196.64
Jul 1979	298.2	199.22
Aug 1979	293.2	200.29
Sep 1979	302.4	201.07
Oct 1979	309.4	200.53
Nov 1979	310.4	199.84
Dec 1979	319.4	200.65
Jan 1980	340.1	215.31
Feb 1980	345.6	214.78
Mar 1980	340.3	214.22
Apr 1980	327.9	214.53
May 1980	335.1P	214.07
Jun 1980	338.4P	

P = Preliminary R = Revised since last month

(1) Australian Bureau of Statistics, Canberra: "Price Index of Materials Used in Manufacturing Industry" (Catalogue No. 6411.0), Table 3.

(2) Australian Bureau of Statistics, Canberra: "Wage Rates, Australia" (Catalogue No. 6312.0), Table 1. Figures for the latest fourteen months shown are subject to revision.

(3) Monthly data for 1970 through 1978 appear on pages 1.7 and 1.8 of Nuexco Report 138.

STATISTICAL DATA

CANADIAN GOVERNMENT STATISTICS

	Industry Selling Price Index: Manufacturing (D 500000)[1,2] (1971 = 100.0)	Wage-earner Data: Average Hourly Earnings (C$)[3,4]		
		Metal Mining, including milling (SIC 050-059)	Primary Metal Industries, non-ferrous (SIC 296-298)	Chemicals and Chemical Products (SIC 370-379)
Annual Avg. 1977	174.3	8.18	6.50	6.51
Annual Avg. 1978	190.4	8.76	6.82	6.97
Annual Avg. 1979	217.9	9.60	7.35	7.67
Apr 1979	212.8	9.68	7.26	7.63
May 1979	214.5	9.65	7.28	7.61
Jun 1979	216.0	9.49	7.27	7.66
Jul 1979	218.3	9.37	7.34	7.73
Aug 1979	220.0	9.56	7.38	7.77
Sep 1979	223.4	9.75	7.50	7.81
Oct 1979	227.4	9.89	7.54	7.88
Nov 1979	228.1	9.97	7.61	7.91
Dec 1979	230.4	9.93	7.51	7.89
Jan 1980	238.9	9.96	7.57	7.99
Feb 1980	240.7R	10.11	7.69	8.08
Mar 1980	239.4	10.34	7.83	8.26
Apr 1980	241.0R	10.40P	7.94P	8.36P
May 1980	243.0	10.49P	8.02P	8.44P
Jun 1980	244.0P	—	—	

P = Preliminary R = Revised since last month

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(1) Statistics Canada, Prices Division, Ottawa: "Industry Price Indexes" (Catalogue 62-011), Table 1. Indexes for the most recent six months shown are subject to revision.

(2) Monthly data for 1973 through 1978 appear on page 1.10 of Nuexco Report 138.

(3) Statistics Canada, Labour Division, Employment and Payrolls Section, Ottawa: "Employment, Earnings and Hours" (Catalogue 72-002), Table 2.

(4) Monthly data for 1977 and 1978 appear on page 1.11 of Nuexco Report 138.

STATISTICAL DATA

REPUBLIC OF SOUTH AFRICA STATISTICS

	Average Declared Working Costs per Metric Ton of Gold Ore Milled (Rand)[1]	**Consumer Price Index[2] (1975 = 100, except where otherwise indicated)**
Annual Avg. 1970 (3)	7.34	100.3 (4)
Annual Avg. 1971 (3)	7.88	106.4 (4)
Annual Avg. 1972 (3)	8.79	113.3 (4)
Annual Avg. 1973 (3)	10.51	124.1 (4)
Annual Avg. 1974 (3)	13.18	138.5 (4)
Annual Avg. 1975 (3)	16.71	157.2 (4)
Annual Avg. 1976 (3)	19.30	174.7 (4)
Annual Avg. 1977 (3)	23.87	194.4 (4)
Annual Avg. 1978 (3)	27.14	137.2
Annual Avg. 1979 (3)	30.18	155.3
May 1979	—	150.6
Jun 1979	29.44	152.4
Jul 1979	—	157.9
Aug 1979		160.2
Sep 1979	30.71	162.1
Oct 1979	—	162.9
Nov 1979	—	163.4
Dec 1979	31.89	164.0
Jan 1980	—	165.4
Feb 1980	—	167.0
Mar 1980	33.65	168.0
Apr 1980	—	170.0
May 1980	—	171.9
Jun 1980	34.08	174.6
Jul 1980	—	—

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(1) Chamber of Mines of South Africa, Johannesburg: "Analysis of Working Results," published quarterly.
(2) Republic of South Africa Department of Statistics, Pretoria: "Government Gazette: Consumer Price Index for Urban Areas."
(3) Historical data for 1970 through 1979 appear on page 4.9 of Nuexco Report 140.
(4) April 1970 = 100.00

MARKET OPPORTUNITIES

Market Opportunities are *active* inquiries in the uranium market to buy, sell, borrow or lend. The data presented in this section are in no way intended to be indicative of the entire uranium market for the time period covered.

URANIUM SUPPLY

Nuexco Reference Number	Thousands of Pounds U_3O_8				Remarks
	1980	1981	1982	1983	
Available for Sale:					
1236			150	150	
1274	200				
1284	250				
1286		150	250	250	
1315			200	200	
1325	750				
1338	250				
1392	300				
1394	250				
1417	1000				UF_6
1475	500				
1476	250	250			
1479	200				
1481		250			
TOTALS	3950	650	600	600	
Available for Loan:					
1175	700				UF_6
1234	700				
1354	600				UF_6
1355	600				
1429	500				
TOTAL	3100				

MARKET OPPORTUNITIES

Market Opportunities are *active* inquiries in the uranium market to buy, sell, borrow or lend. The data presented in this section are in no way intended to be indicative of the entire uranium market for the time period covered.

URANIUM DEMAND

Nuexco Reference Number	Thousands of Pounds U_3O_8				Remarks
	1980	1981	1982	1983	
Inquiries to Purchase:					
1146		100	200	200	
1321		100	300	300	
1408	150				
1410		2000	2000	2000	
1459			200	200	
1462				100	
1470	25				
TOTALS	175	2200	2700	2800	
Inquiries to Borrow:					
1220	500				

MARKET OPPORTUNITIES

Market Opportunities are *active* inquiries in the secondary market for UF_6 conversion services. The data presented in this section are in no way intended to be indicative of the entire market for the time period covered.

CONVERSION SUPPLY

Nuexco Reference Number	Thousands of Pounds U as UF_6				Remarks
	1980	1981	1982	1983	
P-1282	250	250			
P-1417	1000				
P-1449		750			
P-1450	750				
P-1451	175				
P-1474	50				
P-1484	2000	1000	3000	1000	
TOTALS	4225	2000	3000	1000	

CONVERSION DEMAND

Nuexco Reference Number	Thousands of Pounds U as UF_6				Remarks
	1980	1981	1982	1983	

NUEXCO
NUCLEAR EXCHANGE CORPORATION

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EXECUTIVE SUMMARY & INDUSTRY OVERVIEW
NUEXCO REPORT 145

The **Exchange Value** dropped to $30.00 per pound U_3O_8, down from $31.50 last month. Competition by non-US producers to sell in the US market were primarily responsible for the downward price pressure. Some inventory holders stepped up their efforts to sell, thus providing an additional downward influence on prices.

The market was relatively active this month as ten transactions closed. Significant among them was a relatively large near-term sale by a Canadian producer to a US utility. Also, three transactions closed this month involving US utilities as sellers. Queensland Mines, Ltd. of Australia announced a long-term contract involving the sale of 1.8 million pounds U_3O_8 to TVO of Finland.

The **Australian** government announced the initialing of a series of contracts involving the sale of about 68 million pounds U_3O_8 from Ranger. These sales are in connection with the formation of Energy Resources of Australia (ERA) and the sale of the Australian Government's equity in Ranger. The purchasers are utilities and other firms in **Japan** and the **Federal Republic of Germany.**

The **US** Nuclear Regulatory Commission voted to issue a full power operating license to Virginia Electric and Power Company for its North Anna unit 2. This is the first full power license issued in the US since the Three Mile Island accident.

The US Department of Energy's determination of the average price of uranium paid by US utilities in 1979 was $23.85 per pound U_3O_8.

This Report contains a revised Nuexco forecast of **US uranium production.** Nuexco expects that US production will decline from the 1979 level of about 37 million pounds U_3O_8 to about 34 million pounds in 1980, and to about 20 million pounds by the mid-1980's. The expected decrease is due to declining ore grades, depletion of orebodies, and production cutbacks resulting from high user inventories and competition from non-US producers.

This Report also contains a re-assessment of the uranium **supply/demand balance** through 1990. Because of reduced estimates of future consumption, especially in the US, world commercial uranium inventory levels are expected to remain very high, at about three years forward consumption throughout the period of the estimate.

This month's *Topical Essay* focuses on the past economics of the US uranium industry, as a guide in predicting future US production levels.

The *Raw Materials* section discusses the uranium production picture in **Argentina.**

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9/80

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OCTOBER 1980 **NUMBER 146**

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Monthly Report on the Uranium Market

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NUEXCO

MONTHLY REPORT ON THE URANIUM MARKET

October 1980 No. 146

JAMES E. VAUGHAN, *EDITOR*

FOREWORD ii

THE URANIUM MARKET

AUSTRALIA 1
CANADA 2
EUROPE 4
FAR EAST 4
UNITED STATES 4
TRANSACTIONS 6
PRICING 6
CONVERSION 7

TOPICAL ESSAY

THE CURRENT URANIUM MARKET: HAVE WE BEEN THERE BEFORE? 8

COMMENTARY

THE EMBARGO ISSUE 12

RAW MATERIALS

URANIUM RECOVERY BY HEAP LEACHING 13

STATISTICAL DATA

EXCHANGE AND TRANSACTION VALUES 16
LOAN USE CHARGE RATE 19
CURRENT TRANSACTIONS 20
OPTIMUM TAILS ASSAY 21
GOVERNMENT STATISTICS 22

MARKET OPPORTUNITIES

URANIUM SUPPLY 26
  Available for Sale
  Available for Loan
URANIUM DEMAND 27
  Inquiries to Purchase
  Inquiries to Borow
CONVERSION SUPPLY AND DEMAND 28
INDEX 29

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FOREWORD

Nuexco will host a luncheon at the Atomic Industrial Forum annual meeting at the Washington Hilton on Monday, November 17, 1980. Invitations will be sent out shortly; please reserve the date.

An index of topics covered in the Nuexco Monthly Report over the last twelve months is included at the end of this Report. The index will be updated on a continuing basis in each Monthly Report.

Table 11 of Report 145 was garbled somewhat in typesetting. A new Table 11 is included as an insert to this Report.

It is a pleasure to announce that Mr. G. Brian Grega has joined the Nuexco staff this month as an Associate. Brian is a recent graduate of the University of California at Berkeley, where he majored in economics.

NUEXCO

URANIUM MARKET

AUSTRALIA

Information on the structure, finances and sales of Energy Resources of Australia (ERA) will become available from the prospectus relating to its offering of some 57 million shares of stock to the Australian public. Some details now available are as follows:

1. ERA will be capitalized at 500 million shares of which only 405.9 million shares will be initially issued as follows:

	Millions of Shares	Percent
PEKO-Wallsend	125	30.8
EZ Industries	125	30.8
Japan-Australia Uranium Resource Development Company, Ltd. (JAURD)	41	10.1
Urangesellschaft	16.4	4.04
Rheinische Braunkohlenwerke (A subsidiary of RWE)	25.625	6.31
Saarberg-Interplan	15.375	3.79
Australian Public	57.5	14.16
Totals	405.9	100.00

2. 4.1 million shares will be held in reserve for issue to a utility which is expected to enter into a long term contract to purchase U_3O_8 from ERA. However, negotiations for this issue, which would be equivalent to one percent of then outstanding shares, have yet to be undertaken.
3. Japan-Australia Uranium Resource Development Company, Ltd. (JAURD) is jointly held by Kansai Electric (50 percent), Kyushu Electric (25 percent), Shikoku Electric (15 percent) and C. Itoh and Company (10 percent). C. Itoh will manage JAURD.
4. The initial overseas owners will hold 98.4 million shares or 24.2 percent of ERA for which they will pay A$98.4 million.
5. Project financing will be provided by loans from JAURD (US$140 million), a consortium of banks headed by J. Henry Schroder-Wagg and Continental Illinois (US$250 million), Peko Wallsend and EZ Industries (US$30 million each). The loans are repayable over approximately eight years following project start up.
6. U_3O_8 sales to the new shareholders totaling 67.5 million pounds U_3O_8 and other ERA commitments totaling 16.2 million pounds are shown in Table 1. This is a revision of the data presented in Nuexco Report No. 145.
7. Contracts with the foreign shareholders extend over 15 years. Prices are fixed for 1982 delivery; are subject to escalation for 1983 and 1984 delivery; and, in 1985 and later, are based on international market prices subject to an escalating floor price. Escalation is based on Australian labor and material indexes and applies to less than 100 percent of the base price. Deliveries may be terminated after 1990 if prices paid have exceeded market price at the time of delivery over some predetermined period of time. Provisions also exist for cessation of escalation of the floor price if it exceeds market price. Although the floor price mechanism is rigid there is a debit and credit system. Under the system, the buyer can accumulate paper credits during a period in which the floor price is higher than market price. The paper credits can be recouped at such later time as market price exceeds floor.
8. Sales other than to ERA participants are for varying periods of time up to 13 years, at prices related to market subject to floors. Some contracts contain provisions for termination of deliveries if prices actually paid exceed market price at delivery.
9. All sales have been made in US dollars.

The Ranger mill is designed to process 3850 short tons per day at a head feed grade of 0.30 percent U_3O_8, producing 6.6 million pounds U_3O_8 annually, and is scheduled to commence commercial operations in October 1981. In order to meet 1982 delivery commitments, the mill will have to start up on time and operate at or close to full-rated output.

In a separate development Canada's Denison Mines, Ltd. has won approval from the Australian government to purchase the Koongarra deposit from Noranda Mines, Ltd. This transfer is from one Canadian entity to another, and does not alter the Australian requirement for 75 percent Australian equity prior to development. Denison will face the same aboriginal, environmental and related problems that have stalled Noranda in developing Koongarra.

Western Mining Corp., Ltd. has commenced operation of its Kalgoorlie Research Plant in Western Australia. The plant is the principal part of the first stage of development of the Yeelirrie project. It was built as a pilot plant for testing the Yeelirrie

Table 1

ENERGY RESOURCES OF AUSTRALIA (RANGER) SALES COMMITMENTS, BY YEAR

(thousands of pounds U_3O_8)

	1981/1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
American Electric Power Co.	500	500	500	500	500	500	500	500	500	—	—	—	—	—	—
Korea Electric Co.	—	500	500	500	500	500	500	500	500	500	500	—	—	—	—
Federal Republic of Germany[1]	2,100	2,240	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800
JAURD	1,200	1,200	1,500	1,500	1,500	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
Other Japanese Contracts[2]	1,760	600	600	600	800	—	—	—	—	—	—	—	—	—	—
Repayment of loan to Australian Government	1,000	1,000	228	—	—	—	—	—	—	—	—	—	—	—	—
Contracts under negotiation	50	50	50	300	300	300	300	300	300	300	300	300	300	—	—
Totals	6,610	6,090	6,178	6,200	6,400	6,100	6,100	6,100	6,100	5,600	5,600	5,100	5,100	4,800	4,800

[1] The three participants in ERA from the Federal Republic of Germany are Urangesellschaft, Saarberg-Interplan and Rheinische Braunkohlenwerke, a subsidiary of RWE.

[2] These contracts with Kyushu Electric and Chubu Electric were first signed in the early 1970's.

metallurgical circuit on a continuous basis. About 8,000 tonnes of ore will be processed through the plant in the first phase. Figure 1 is an overview of plant. Figure 2 is a closeup of the concentrate thickeners.

CANADA

The uranium industry in Canada continues in a relatively positive stance regarding exploration and production. At Elliot Lake, Rio Algom, Ltd. continues in its expansion program to bring the Stanleigh facility back into production after 20 years of dormancy. This will bring Rio Algom's total mining and milling capacity at Elliot Lake up to 15,000 tons per day when completed. The current schedule calls for completion by 1984.

Denison Mines, Ltd. is also continuing development to attain 15,000 tons per day capacity. In addition, Denison has moved to acquire the Koongarra deposit in Australia's Northern Territory from Noranda Mines, Ltd.

In Saskatchewan, Gulf Minerals Canada, Ltd. (GMCL) and its partner Uranerz Canada, Ltd. continue in their aggressive program of production and exploration. The Rabbit Lake production center, which produced approximately 5.4 million pounds U_3O_8 in 1979 at an average grade of 0.39 percent, is expected to continue to run long after the reserves in the Rabbit Lake mine are exhausted. It is currently estimated that about half of the 40 million pounds of reserves at Rabbit Lake have been mined out since the facility began operating in 1975. However, reserves estimated at an additional 50 million pounds U_3O_8 have been discovered at Collins Bay, about six miles northeast from Rabbit Lake. GMCL plans to begin feeding Collins Bay ore to the Rabbit Lake mill as early as 1982 if government approval can be obtained by then. GMCL's latest discovery is at Eagle Point, about eight miles north of Rabbit Lake. The ore grade of both Collins Bay and Eagle Point is estimated to be about 0.40 to 0.50 percent U_3O_8.

Canadian producers continue their presence in the US uranium market and elsewhere, and will probably continue to compete for near and longer term sales.

The chairman of Canada's Royal Commission on Electric Power Planning has announced his support of the expansion of nuclear power in Canada. Dr. Arthur Porter is calling for the aggressive implementation of nuclear power throughout Canada, not only for domestic use, but also for export of electric power to the US. Dr. Porter's position has changed considerably since the formal issuance of the Royal Commission's recommendations in March, 1980. At that time, the Commission took a much more cautious view of nuclear power expansion in Canada.

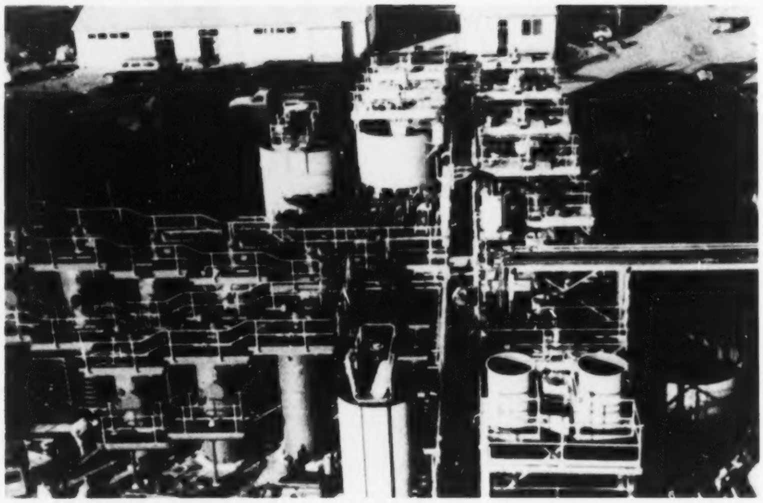

Figure 1
THE PILOT PLANT RECENTLY COMMISSIONED BY WESTERN MINING CORP. IN WESTERN AUSTRALIA. THE PLANT WILL BE USED TO TEST ORE FROM YEELIRRIE.

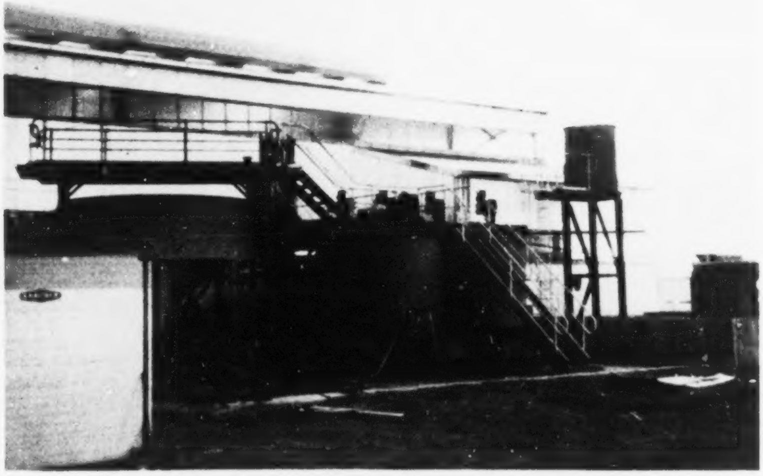

Figure 2
CLOSEUP OF THE CONCENTRATE THICKENERS.

A bill has been introduced into the Canadian House of Commons which would severely limit the enforceability of foreign antitrust judgments in Canada. The bill, entitled the Foreign Proceedings and Judgments Act, would empower Canada's Attorney General to prohibit or restrict disclosure of Canadian business records in foreign antitrust proceedings, and to declare foreign antitrust judgments unenforceable in Canada. The act would also enable Canadian citizens to sue in Canadian courts to recover amounts paid in antitrust judgments outside of Canada.

EUROPE

France has reached an accord with Australia on a bilateral agreement under which the French may import Australian uranium. The agreement has been approved at the cabinet level of both nations, and will be submitted to both governments for ratification. The agreement requires that Australian uranium be used only for peaceful purposes. Also, the Australian safeguards code calls for Australia to maintain the prior right of approval for reprocessing and resale. Euratom has not yet signed an agreement with Australia, mainly due to the prior approval issue. The draft agreement between France and Australia will be submitted to Euratom headquarters in Brussels, in accordance with Euratom policy.

A referendum was recently held in the canton of Zurich in **Switzerland** concerning the Kaiseraugst nuclear power project. Voters narrowly endorsed the project by a vote of 51 percent in favor and 49 percent opposed. The referendum was styled "consultative only," and is not legally binding since the Kaiseraugst site is not located in the canton of Zurich. However, the vote is expected to have some political influence on the Swiss Parliament, which has final authority to approve the project.

FAR EAST

During August 1980, **Japan's** 21 commercial nuclear power plants established record levels for availability and utilization. These plants, representing a total capacity of about 15,000 MWe, had an availability factor of 81.5 percent and a capacity factor of 73.5 percent.

Tokyo Electric received approval for units 3 and 4 at its Fukushima II station. These will be 1100 MWe boiling water reactors, one to be supplied by Toshiba and the other by Hitachi. Start-ups are scheduled for 1985.

An update of Japan's participation in the Ranger project is contained in the Australia section of this Report.

UNITED STATES

Senator Peter Domenici (Republican, New Mexico) introduced an amendment to the 1981 appropriations bill for the US Department of Energy (USDOE) which contained language aimed at limiting use of imported uranium in US reactors. The amendment was deleted by a House-Senate conference committee. This action and the issue of embargoes in general are discussed in the *Commentary* section of this Report.

The September 23, 1980 referendum vote in Maine to close the Maine Yankee nuclear power plant was soundly defeated by a three to two margin. There are five other antinuclear initiatives scheduled for November of this year. The states involved are Mississippi, Oregon, Montana, Washington and South Dakota. In Mississippi and Oregon, the initiative would require voter approval for nuclear power plant licensing, construction or operation until a federal waste disposal facility is in existence. The Montana initiative would forbid the disposal of wastes produced by milling or other methods of processing ore in the state. The Washington state initiative would prohibit the importation of high-level waste from other states unless otherwise permitted by interstate compact. The initiative proposed in South Dakota would require a popular vote prior to starting any uranium mining or other nuclear development project.

The US Senate voted 48 to 46 in favor of exporting 40,000 kilograms of enriched uranium to India for fueling the Tarapur nuclear power plant. President Carter assured the Senate that no subsequent deliveries of material will be shipped unless India agrees to safeguard inspections. The House had previously voted against the shipments to India by a margin of 298-98. However, under the US Nuclear Nonproliferation Act of 1978, a resolution of both houses is required to override the President's decision

URANIUM MARKET

to overrule the US Nuclear Regulatory Commission (NRC). President Carter had previously overruled the USNRC, which had voted against the export to India because India does not permit full scope inspection of its nuclear power program.

Exploratory uranium drilling in the US could be down as much as 35 percent in 1980, based upon preliminary midyear drill footage. An estimated nine million feet were drilled in the first half of 1980 down from 14 million feet in the first half of 1979.

The weak uranium market continues to take its toll on US uranium production as additional cutbacks and delays were announced this month. Development of the Hansen ore body in Colorado has been delayed indefinitely. The deposit is jointly owned by Amoco Minerals and Wyoming Minerals. Also, Kerr McGee Nuclear Corporation announced a two year delay in the development of its Powder River Basin deposits in Wyoming. Excessive government regulations were cited by Kerr McGee, in addition to the weak market for uranium. Additional layoffs in Wyoming were announced by both Pathfinder Mines Corp. and Federal-American Partners. Finally, Western Nuclear, Inc. is closing its Sheep 1 underground mine near Jeffrey City, Wyoming. The mine will be kept in standby condition and could be reopened in the event that market conditions improve.

USDOE issued its annual "Survey of United States Uranium Marketing Activity" this month. The report is a compilation of responses to a survey among US uranium industry participants. The data reported by USDOE in the survey include estimated US uranium production potential for the years 1980 through 1990. It is interesting to compare these figures with Nuexco's forecast of US production. The comparison is tabulated in Table 2 for the years 1980 through 1983. As indicated, the USDOE figures for US production potential are much higher than the Nuexco forecast of US production. The reasons for the difference include the following:

1. The USDOE survey was taken when the uranium market was stronger than it is now. Much of the material listed under the column heading "Available for Sale" will probably not be produced.
2. Many existing supply contracts are known to have flexibility provisions which allow the rescheduling of deliveries to later years. Also, some market price contracts have floor price provisions which allow the seller the option to cancel deliveries if market price is below the floor.
3. Some supply contracts are *requirements* type, under which the seller has the obligation to supply the buyer's requirements based on certain ground rules. Other contracts are *output* type, under which the seller has the obligation to deliver only if the production facility produces. In the case of both requirements and output contracts, actual performance is often different from what might be predicted.
4. Continuing litigation in the uranium industry can be expected to result in many deliveries not being made. For example, according to the USDOE survey, about eight million pounds U_3O_8 listed under 1980 sales commitments are characterized as "under litigation."
5. The nature of USDOE data gathering for this publication can affect the results somewhat. Answers to surveys are often "official" company positions, as opposed to estimates of what will most likely happen.
6. Many US producers are now considering purchasing on the open market to deliver under existing supply contracts, rather than produce the material themselves. This is another effect directly attributable to the weakened market.

Nuexco's forecast of US production is based on the probable reactions of the participants in the industry to the current uranium market situation. The continuing stream of announced delays, cutbacks and shutdowns in the US industry indicates of the degree of retrenchment to be expected.

Also of interest in the USDOE survey is the degree to which delays and cancellations of US nuclear power plant projects show up in utility reports of uranium requirements. According to the USDOE survey, unfilled uranium requirements of US utilities were 75,700 tons U_3O_8 as of January 1, 1980. This is compared to 176,000 tons as of January 1, 1978, and 135,100 as of January 1, 1979. The main reasons for the drop are cancellations and delays of reactor projects, rescheduling resulting from conversion to the adjustable fixed commitment enrichment con-

Table 2
COMPARISON BETWEEN USDOE SURVEY OF US PRODUCTION POTENTIAL AND NUEXCO FORECAST OF US PRODUCTION
(millions of pounds U_3O_8)

	USDOE Survey[1] Results			
Year	**Sales Commitments**	**Available for Sale**	**Total US Production Potential**	**Nuexco Forecast of US Uranium Production[2]**
1980	47.0	5.2	52.2	35
1981	42.0	6.2	48.2	31
1982	40.8	8.6	49.4	29
1983	36.6	14.2	50.8	27

[1] George F. Combs, Jr. and S. Victoria Krusiewski: "Survey of United States Uranium Marketing Activity," USDOE; Washington, D.C.; July, 1980; USDOE/RA-0053.
[2] Nuexco Report 145, Table 7.

tract, and new contracts for uranium supply signed during 1978 and 1979.

Average uranium prices as reported by the utilities in the USDOE survey are as follows:

Year	**Average Price (dollars per pound U_3O_8)**
1979	23.85
1980	25.40
1981	30.45
1982	32.55

These prices include market price contracts to the extent that settlements have already been made. The prices are expressed in year of delivery dollars. To the extent that these average prices include contracts under litigation, the data may be somewhat skewed to the low side. In any case, when these prices are compared to Nuexco's estimates of US production costs (see Nuexco Report Number 142, page 12), it suggests that the US uranium industry, on the average, is not operating profitably. Nuexco estimates that the median full cost of production in the US uranium industry is currently about $30.00 per pound U_3O_8.

TRANSACTIONS

Three transactions closed this month. All were traditional producer to utility sales. A US producer sold between 100,000 and 300,000 pounds U_3O_8 for near term delivery to a European utility. Another US producer sold a quantity between 600,000 and one million pounds U_3O_8 to a US utility for delivery over the period 1981-85. Finally, a US producer sold between 50,000 and 100,000 pounds U_3O_8 to a European utility.

PRICING

September's market action resulted in a further decline of the **Exchange Value** to $28.50 per pound U_3O_8, and followed the general pattern seen during the previous several months. Sellers outnumber buyers, and the material available for sale was in excess of quantities being sought. Sellers have therefore been competing vigorously for each new piece of business. The situation has been exacerbated by non-conventional sellers, utilities and other inventory holders.

The momentum of the decline in prices may be beginning to ease, however. The nature of the active bids and offers in the market could signal the approach of some stability in prices. The prices of current spot bids are low but fixed. Some bids for near term material are also at fixed prices. This represents a change from a few months ago when bids for near term delivery often included adjustments for declines in market price.

In addition, the market is becoming somewhat more balanced than it has been in the recent past. Inquiries to sell within the next 12 months (i.e. spot and near term material) total about 4.7 million pounds U_3O_8. Inquiries to purchase within the next 12 months total about two million pounds. Non-US utilities are taking advantage of current prices to purchase spot and near term quantities from US sellers. Also, at least one US utility has decided to enter the near term market. Several US utilities are active in the intermediate and long term markets, but only a few deals have in fact been closed recently.

The **Transaction Value** decreased this month to $30.60 per pound U_3O_8.

CONVERSION

No transactions closed this month in the secondary market for conversion services. However, an inquiry surfaced this month for a large quantity of conversion, with UF_6 delivery scheduled for 1981. Nuexco estimates that transactions for conversion services can be completed in the secondary market for about $1.50 per pound U as UF_6.

TOPICAL ESSAY

THE CURRENT URANIUM MARKET: HAVE WE BEEN THERE BEFORE?

Hardly a week passes in recent times without some announcement or rumor of layoffs, cutbacks or shutdowns in the US uranium production industry. Nearly all US producers have announced cutbacks because of the weak market, and many new projects have been delayed or cancelled. Nuexco estimates that more than fifty percent of US production is being produced at a cost greater than recent Exchange Value levels.

Today's Market Compared to the Early 1970's

It has been observed by some that the current depressed state of the uranium industry is similar in many ways to the depression of the early 1970's. The average Nuexco Exchange Value for 1972 was $5.95 per pound U_3O_8, and few, if any, producers were profitable. Few long term contracts were being signed at that time apparently due to a percention by buyers of an ample supply of uranium, relative to demand. A very strong buyers' market prevailed.

It is worthwhile to focus on one similarity between the market of the early 1970's and today's market; a similarity which has only recently become apparent. US consumption in the early 1970's was low in relation to US production. However, it was then projected that uranium consumption would increase rapidly, and thus US demand would soon outstrip US production capacity. For example, a projection[1] by the US Atomic Energy Commission (AEC) of US demand published in April 1973 showed that demand would equal the then-current US production rate within two years, and would exceed the then-current US production rate by some 25 million pounds annually within five years. The demand projection was based on what proved to be a highly optimistic projected growth rate of US installed nuclear capacity. However, the apparent result at that time was that US buyers began to perceive a uranium supply crunch. This perception, combined with the implementation by the USAEC of the fixed-commitment enrichment contract, led to an unprecedented increase in buying activity in 1973, when requests for offers for future uranium deliveries issued by US utilities amounted to over 320 million pounds U_3O_8. Prices responded by moving higher.

The US supply/demand situation outlined above for the early 1970's is, *per se*, not very much different from that outlined in Nuexco Report 145 for the current market. The tables from Report 145 containing world and US supply/demand data are reproduced here as Table 3 and Table 4. Table 4 indicates that current US consumption of uranium is low, relative to US production. 1980 consumption is estimated by Nuexco at 18.1 million pounds U_3O_8, compared to 1980 US production of 34.5 million pounds U_3O_8. Further, the same table shows Nuexco's estimates of US production about equal to US consumption in 1982, only two years hence (production of 28.5 million pounds, consumption of 29.9 million pounds). Finally, the table shows US consumption rising above US production in the mid-1980's by more than 20 million pounds annually. The reasons for the projected falloff in US production, discussed in Report 145, are related principally to current and expected weak market conditions, and not to any shortfall in US uranium resources.

Thus many veterans of the uranium industry are viewing today's market situation as something very much like what they have seen before. Even the apparent new low-cost production from non-US sources was foreseen in the early 1970's. At that time, the deposits in Australia's Northern Territory and some in Canada's northern Saskatchewan district had already been discovered.

The question that naturally follows from these similarities is whether the market can be expected to recover in the way it did in the mid-1970's. The answer, as is usually the case in the behavior of a commodity market, will revolve around market perceptions.

Market Perceptions—A Look at the Copper Market

Market prices for most commodities tend to vary in roughly a cyclical pattern. As perceived supply grows relatively short, prices tend to increase. Similarly, when market participants view supply as abundant, prices tend to ease. The copper market is a mature market in comparison to uranium, and it might be instructive to trace how changes in perception in the copper market can translate to price movements.

The copper market was in the doldrums just two years ago. In 1978, world inventories of copper were relatively high, especially the very visible inventories in the London Metal Exchange (LME) and the

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[1] Survey of United States Uranium Marketing Activity," USAEC; Washington, D.C.; April, 1973; WASH-1196(73).

TOPICAL ESSAY

Table 3
NATURAL URANIUM SUPPLY-DEMAND BALANCE: WOCA[1]
(millions of pounds U_3O_8)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
PRODUCTION[2]												
Operating Production Centers	98.5	103.3	105.8	104.3	104.8	104.1	101.1	100.1	99.2	99.0	99.0	99.0
Facilities under Construction	-0-	0.6	6.4	8.9	12.9	17.7	19.8	20.8	20.6	20.6	20.6	20.6
Total	98.5	103.9	112.2	113.2	117.7	121.8	120.9	120.9	119.8	119.6	119.6	119.6
less												
CONSUMPTION[3]	68.7	57.7	74.1	85.3	93.9	100.2	113.4	112.5	113.7	114.1	115.0	114.1
equals												
NET INVENTORY INCREASE	29.8	46.2	38.1	27.9	23.8	21.6	7.5	8.4	6.1	5.5	4.6	5.5
plus												
BEGINNING INVENTORY	160.0[4]	189.8	236.0	274.1	302.0	325.8	347.7	354.9	363.3	369.4	374.9	379.5
equals												
ENDING INVENTORY	189.8	236.0	274.1	302.0	325.8	347.4	354.9	363.3	369.4	374.9	379.5	385.0
RELATIVE INVENTORY[5] (yrs)	2.3	3.3	3.2	3.2	3.2	3.3	3.1	3.2	3.2	3.3	3.3	3.3

[1] World outside Communist areas.
[2] Nuexco Report 145, Table 9.
[3] Natural uranium entering enrichment-fabrication pipeline for later use in a reactor. Nuexco Report 144, Table 1.
[4] Nuexco Estimate.
[5] For each year, Relative Inventory equals Beginning Inventory divided by Consumption.

Table 4
NATURAL URANIUM SUPPLY-DEMAND BALANCE: US
(millions of pounds U_3O_8)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
PRODUCTION[1]												
Operating Production Centers	37.0	34.2	29.3	26.0	24.7	22.0	19.0	17.1	16.3	16.2	16.2	16.2
Facilities Under Construction	-0-	0.3	2.0	2.5	2.7	3.0	3.0	3.0	2.8	2.8	2.8	2.8
Total	37.0	34.5	31.3	28.5	27.4	25.0	22.0	20.1	19.1	19.0	19.0	19.0
less												
CONSUMPTION[2]												
Reactors Now Operational	16.3	17.4	17.4	17.1	18.0	18.0	18.1	17.4	17.6	18.3	18.2	17.7
Now Under Construction	8.5	0.7	7.5	12.8	17.2	22.2	25.4	30.0	27.1	30.3	27.2	27.6
Now On Order	-0-	-0-	-0-	-0-	-0-	-0-	-0-	0.9	0.3	0.3	3.4	2.0
Total	24.8	18.1	24.9	29.9	35.2	40.2	43.5	48.3	45.0	48.9	48.8	47.3
plus												
NET IMPORTS (EXPORTS)[3]	(1.8)	(1.9)	0.3	1.5	1.2	1.7	0.1	0.6	0.6	0.6	1.0	1.1
equals												
SUPPLY SURPLUS (DEFICIT)	10.4	14.5	6.7	0.1	(6.6)	(13.5)	(21.4)	(27.6)	(25.3)	(29.3)	(28.8)	(27.2)
plus												
BEGINNING INVENTORY	66.4[4]	76.8	91.3	98.0	98.1	91.5	78.0	56.6	29.0	3.7	-0-	-0-
equals												
ENDING INVENTORY	76.8	91.3	98.0	98.1	91.5	78.0	56.6	29.0	37.0	-0-	-0-	-0-
RELATIVE INVENTORY (yrs)[5]	2.7	4.2	3.7	3.3	2.8	2.3	1.8	1.2	0.6	0.1	-0-	-0-

[1] Nuexco Report 145, Table 7.
[2] Nuexco Report 144, Table 1.
[3] Nuexco Report 142, Table 3.
[4] George F. Combs, Jr.: "The US Uranium Market—1978-1979" USDOE; Grand Junction, Colorado; October, 1979.
[5] For each year, Relative Inventory equals Beginning Inventory divided by Consumption.

Comex warehouses. Prices were low, due in part to the perception of ample supply based on the large inventories. The LME average price for copper wirebar during 1978 was about US$0.62 per pound, estimated to be below the full cost of production of many mines.

The price of copper began to recover in late 1978 and early 1979. Severe production and shipping problems in Zambia and Zaire resulted in a draw down of inventories. The potential for strikes in the US was viewed by users and speculators as a reason to maintain relatively high inventories. The perception of a possible shortage thus caused the price to be bid up. The average LME price in 1979 was about US$0.90 per pound, and reached around US$1.40 per pound in early 1980.

World (outside communist areas) copper inventory levels had been above 2.2 million tons in early 1978, and decreased to 1.2 million tons by the end of 1979. For comparison, world (outside communist areas) copper consumption in 1979 was about 8.25 million tons, and production was 7.7 million tons. Thus world copper inventories at the end of 1979 were drawn down to about an eight week supply. This was perceived as a relatively tight inventory situation given the real and potential supply shortfalls at the time, and was a principal cause of the rising price of copper during 1979 and early 1980.

Effect of Inventory

The inventory in any commodity is the surge tank between production and consumption. The relative inventory level often serves as a bellwether of commodity price movements. In the copper market, an inventory of 1.2 million tons was viewed as insufficient at a time when buyers perceived the existence of, or possibility of, production problems in some areas of the world. (At other times, such an inventory level has been viewed as sufficient.)

Returning to the uranium market and the comparison between the current situation and the market in the early 1970's, the question of inventory levels should be addressed. Inventories in the copper market are relatively thin in comparison to the uranium market. World copper inventories are on the order of a few months' consumption at most, while world (outside communist areas) uranium inventories, as well as US inventories, are currently at least three times annual consumption (see Table 3 and Table 4). One result of the difference is that the copper market can be expected to be relatively volatile with changing market perceptions quickly leading to price movements. The economic cycle for uranium appears to be much longer.

US commercial uranium inventories as of the end of 1972 were small, compared to the current situation. In 1973, the USAEC estimated[2] that US commercial inventories as of the end of 1972 amounted to about 25 million pounds U_3O_8. Predicted forward annual requirements at that time were about 16 million pounds in 1973, and 23 million pounds in 1974. The dampening effect of inventory was therefore much lower than today, and perceived shortfalls were quickly translated into market action. Much buying activity commenced in 1973, and prices were continuously bid up through early 1976, when they reached a broad plateau. Today, US commercial inventories of natural uranium are expected to be in excess of 90 million pounds U_3O_8 by the end of 1980, much higher than predicted annual US consumption over the next few years. This high inventory will probably tend to act as a buffer to changes in market perceptions brought on by the predicted shortfall in US production in the mid-1980's. There will be other factors to consider as well, such as non-US production. However, the most important factor is likely to be the effect of inventories. The influence of the industry's inventory level on the market will in turn depend on the collective judgment of the individual utilities on how much inventory is really needed.

Unique Aspects of Uranium Inventory

In the US, the nuclear power industry could operate on inventory alone for at least three years. This of course greatly contributes to the perception of a more-than-adequate supply of uranium. Some of this utility inventory has been recycled into the market, contributing to downward pressure on prices. The mere fact that some inventory has been sold into the market tends to further aggravate an already bearish situation because of the potential for additional inventory sales; i.e. a domino effect. US utility inventories are unevenly distributed, and several US utilities hold more than five million pounds each. The decision of only one of these utilities to liquidate would put great downward pressure on what is now a thin market.

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[2] *Ibid.*

TOPICAL ESSAY

Pricing considerations which apply to inventory selling are different than those associated with classical economic pressures. Decisions to build or liquidate inventories are largely, though not wholly, policy decisions dependent in part on perceptions related to security of supply, future price outlook, utility cash requirements, etc. Much depends upon financial treatment and tangibles. One important intangible is the ability of the utility to recover its cost of carrying the uranium inventory. A federal agency, the Federal Energy Regulatory Commission (FERC) is now developing guidelines which will influence whether and to what extent US utilities are compensated for inventory carrying charges. Thus utility inventory decisions are likely to be based upon a broad spectrum of considerations.

With inventories in such a pivotal position, utility decisions on this issue can literally dominate the market. If wholesale decisions are made to reduce inventories (or, in a thin market, if only a few such decisions are made), spot market prices are likely to be depressed well below what might be expected by analyzing only production and consumption. If, on the other hand, utilities view inventories as being beneficial, the apparent shortfall in US production over the next few years might be perceived as to bring about a real resurgence in interest in long term supply contracts. Utility patterns and policies regarding inventories are the all-important difference in the current market vis-a-vis the early 1970's. These patterns and policies must be carefully monitored if the behavior of the market is to be accurately assessed.

COMMENTARY

THE EMBARGO ISSUE

US Senator Peter Domenici (Republican, New Mexico) was successful in attaching an amendment to the Senate's version of the 1981 US Department of Energy (USDOE) appropriations bill. The amendment had the potential to limit the use by US utilities of non-US origin uranium. However, the proposed amendment was deleted by a House-Senate conference committee, and the final bill forwarded to the President did not include any language related to an embargo.

The defeated amendment was somewhat peculiar. The first section prohibited enrichment of feed for use in the US reactors where the foreign feed component exceeded 10 percent, but excluded from this prohibition all enrichment contracts signed prior to October 1, 1980. Since US reactors either operating, under construction or on order are already covered by enrichment contracts and since the bill was an appropriations bill covering only one fiscal year, this section was essentially meaningless.

The second section of the proposed amendment, however, directed USDOE to conduct a rulemaking to establish restrictions on the domestic use of foreign origin uranium to the extent necessary to protect the viability of the US uranium production industry. It was this latter provision that brought forth the strongest reactions from US utilities, the US Department of State and the US Department of Energy.

US utilities generally went on record as opposing any actions that would reduce uranium procurement flexibility. The Department of State had to contend with objections from Canada and Australia, which feared the cut-off of potential markets. USDOE felt that a rulemaking was premature and reported that the balance of uranium imports and exports is under continuing study in the Department, and its view was that imports of non-US uranium were clearly not a factor in the recent price weakness reflected in the market. Thus a reimposition of the embargo would not likely have a significant effect on spot prices in the US.

The popular press has picked up on the issue of potential US uranium import dependence. The possibility of such dependence has become more apparent in recent months as weakening prices have led to many production cutbacks in the US, with more expected. The resultant shortfall in production will likely be compensated to a significant extent by imports.

Thus if some import dependence is expected, the comparison between imported oil and imported uranium naturally arises. One reason often given in favor of a uranium import embargo is the prevention of problems in the uranium market similar to the current problems in oil. There are, however, fundamental differences between uranium import dependence and oil import depedence, which are often overlooked in drawing these comparisons.

Production and Consumption: The US does not have the capability to produce all the oil it currently consumes. Oil usage is currently around 17-18 million barrels per day. US production is only about 9 million barrels per day. On the other hand, the US has the current capability to produce over 40 million pounds U_3O_8 annually and production could be expanded to 50 million pounds within a few years if required and if market conditions permitted. Consumption however is currently less than 25 million pounds annually. Thus the situations vis-à-vis oil and uranium are opposites with respect to production versus consumption.

Fuel Characteristics: When oil supplies are cut off the effects are immediate. The physical capability to inventory oil is limited. Uranium is substantially different. Large inventories, equivalent, in aggregate, to at least three years forward consumption are now on hand. There is no limit, other than financial, to the amount of U_3O_8 that can be inventoried. Thus even if substantial foreign deliveries were cut off, existing inventories could absorb any shortfall for years. The existing US government strategic stockpile is a further buffer. Finally, the characteristics of nuclear power plants allow their operation to be extended, adding still a further buffer. Thus there would be more than adequate time to increase US production to the level necessary to make up for any foreign supply that might be cut off.

Thus attempts to draw parallels between the existing situation in the US with respect to dependence on foreign oil and the degree of prospective dependence on foreign uranium tend to ignore important basic differences between the two commodities and can lead to inaccurate conclusions.

RAW MATERIALS

URANIUM RECOVERY BY HEAP LEACHING

Generally, the uranium production industry has been processing ores of lower average grade during the last few years. This is particularly true in the United States where the average grade of conventional milling operations has decreased from 0.20% U_3O_8 in 1970 to 0.11% in 1979. The average grade of ore processed is the most important cost consideration involved in producing a pound of uranium oxide. Thus, as the average grade of ore decreases, alternative recovery technology is becoming important in maintaining or improving project economics.

This does not necessarily apply to every project. The economics of a large-tonnage mine and mill operation may be proportional to the volume of material processed; average grade of the material becomes a secondary consideration to volume. The Rossing operation in Namibia is an example. The average grade of mill feed at Rossing is between 0.035 and 0.045 percent U_3O_8; mill volume is about 40,000 tonnes per day.

Uranium produced as a by-product or co-product of another mineral in the ore, will normally not be amenable to alternative recovery technology because most of the recovery costs are assigned to the other mineral. Two examples of this are represented by the recovery of uranium as a by-product to gold recovery from the quartz-pebble conglomerates in the Witwatersrand region of South Africa, and the recovery of uranium as a co-product to vanadium in certain deposits in the Colorado Plateau area of Colorado and Utah.

The need to improve the economics of recovery are perhaps more critical in the US uranium industry than other producing areas. Nuexco has estimated the total cost of about 50 percent of current production in the US—presently at an annual rate of 34.5 million pounds U_3O_8—probably exceed $30.00 per pound U_3O_8. In today's market, such costs leave little or no profit for certain producers. A reduction in future capital and/or operating costs may determine whether or not such producers remain in business.

Opportunities to improve cost related processing methods are somewhat limited for conventional operations. Conventional uranium ore processing methods have remained essentially unchanged since the first plants were built in the early 1950's. Today's operators are utilizing old recovery methods in a new environment of inflated costs and decreasing market potential.

The principle alternatives for reducing production costs are:

1. Raise the cut-off grade of mined ore, and thereby lower unit cost, but at the expense of decreasing mine life by making lower grade ore unavailable,
2. Improve overall mill recovery efficiency. In all probability, prudent operators have already implemented adjustments in both areas, and projects are already at or above, design efficiency.

Attempts to implement these changes have been less than satisfactory for certain operators. Average ore grades have continued to decline. More tons of lower grade ore are being mined and processed to maintain annual production levels. Although average mill recovery has increased from about 87 percent in 1960 to about 94 percent today, the overall contribution to a reduction in costs has not net been significant.

Thus any significant reduction in production costs will have to come through the implementation of new and unconventional recovery techniques. One of the more promising of the techniques is solution mining; the recovery of uranium through dissolution, by the introduction of a suitable leaching solution into the mineral-bearing material.

Solution Mining

Solution mining can occur through the application of several different techniques. The leaching of ore in place—in situ leaching—offers the greatest potential to reduce production costs through a reduction in the number of cost-related operating steps, as compared to conventional mining and milling. However, the application of solution mining to existing conventional operations, is, for all practical purposes, limited to the recovery of uranium from ore by the process of heap leaching—the saturation of ore piles, usually low grade stockpiles or dumps, with a leaching solution to remove at least a part of the uranium contained in the material. The process is a means to recover a portion of sunk costs in low grade material removed from the mine in the normal process of mining higher grade ore, thereby improving the overall economics of the project.

Heap leaching does not require large capital expenditures or high on-going operating costs, as compared to conventional milling, since a number of steps are eliminated. The important areas of cost saving include the elimination of fine grinding, agitation, and liquid/solid separation. Heap leaching costs are limited to mining the material, crushing to optimum size for leaching (most sandstone ore does not require crushing), transportation to the leach site and preparation of the leach site. Final solution purification and precipitation facilities, if required, can be constructed on the site at minimal expense, or the high grade liquor can be transported directly to an existing mill facility.

History of Heap Leaching

Heap leaching is an old and commonly used metallurgical process. It is used to extract metal values from material which does not contain enough values to justify the capital expenditure necessary for the more conventional extraction process designed for higher grade ores. The art of heap leaching began in the 16th century, probably utilizing oxidized copper ores, and possibly gold and silver ores as well. Process technology has advanced rapidly in recent years with the development of hydrometallurgy, and today, heap leaching of many different ores, including uranium, is commonplace. In fact, some five billion tonnes of stockpiled low grade ore and waste dump material is, or is programmed to be, subjected to some form of heap leaching. Copper dumps, primarily in the western US, make up the largest percentage of material being leached.

Heap leaching of uranium ores on a large scale is relatively new, dating back to the early-1960's. The first leaching was done on low grade ore in the Gas Hills district of Wyoming. About 500,000 tonnes of material, containing 0.05 percent U_3O_8, was subjected to heap leaching over a period of several years. A total of approximately 400,000 pounds U_3O_8 was recovered. The success of the initial heap leach project stimulated other projects in the Gas Hills, the Shirley Basin district in Wyoming and the Maybell district in Colorado. In each case, the purpose of the project was accomplished, namely to recover U_3O_8 from material which otherwise could not have been economically processed by conventional methods.

Technology of Heap Leaching

The heap leaching process begins with the introduction of a leaching solution, usually consisting of dilute sulfuric acid, to the surface of a prepared stockpile of low grade material. The acidic solution is allowed to percolate to the bottom of the pile, where it is collected, and stripped of the contained uranium by conventional extraction or ion exchange methods. However, the actual design and operation of a heap leach facility is necessarily preceded by controlled laboratory testing from which a full scale project evolves.

Laboratory tests are conducted on specially selected and prepared samples taken from the stockpile of material being considered for leaching. Such tests are required to determine acid consumption, the rate of solution flow through the ore, the percentage of U_3O_8 recovery and preliminary design parameters. An estimate of project economics can be determined from laboratory tests.

Favorable laboratory tests are normally followed by a pilot test program at the mine site, in which larger volumes of ore are to be leached under design conditions. The pilot tests yield data that are designed into the full scale operation. Specifically, the data refer to the design and construction of the leach pad, the overall tonnage to be stacked on the pad, appropriate particle size and stacking technique to minimize compaction, the flow-rate of the leach solution through the material, the optimum leaching solution and the percentage of uranium recovered. The pilot test results allow for a final assessment of project economics.

The design of a leach pad and the tonnage to be stacked for leaching are influenced by the total volume of material to be leached and/or the availability of a favorable leach site. An ore pile that must be moved at the conclusion of a leach cycle may be limited in size to about 20,000 tonnes of ore. Once the spent ore is removed, a new ore supply can be stacked on the pad and the leaching process resumed. At the conclusion of leaching, the pad site is restored to approved environmental standards. Larger heap leach sites may contain up to 500,000 tonnes ore, all of which remains on site after leaching is concluded.

Design and construction of a heap leach pad is critical to a successful leach operation. The pad site is carefully prepared by grading the surface into evenly spaced troughs across the width. The pad is then made impervious to water flow by means of a tightly packed layer of clay, although polyethelene sheeting is commonly used on small pads. Perforated pipe, usually four to six inches in diameter, is then placed in each trough to collect the leaching solution as it seeps through the ore. A layer of pea gravel is spread over the pad to insulate the perforated pipe from the ore and to facilitate the free flow of solution into the collection system.

The mechanics of loading the pad may vary according to the particle size and compaction qualities of the ore, however, due to the volume of material to be stacked, the most common method is to use dump trucks with a 10 to 15 ton capacity. The oads are dumped on pad and flattened with a crawler tractor to minimize compaction. The procedure is repeated until the desired thickness of ore is achieved.

Thickness of the heap is determined during the pilot testing. Thickness can vary from about one meter up to eight or ten meters for the larger operations. However, experience has demonstrated that a thickness of five to seven meters is optimum for sandstone ores.

Final heap preparation includes the construction of low berms at the top surface of the heap to separate it into several holding reservoirs for the solution. The purpose of the reservoirs is for fine tune control of the leaching solutions, as well as to minimize damage from wave action or washout. At this point the site is ready for leaching.

The leaching solution is prepared in special holding tanks to an acid concentration determined in the pilot operation. It is pumped or sprayed on the reservoir areas and the leaching cycle begins.

The heap is prepared to facilitate complete saturation of the heap by the leaching solution. Dissolution of the uranium begins with saturation and continues as long as the solution is in contact with the uranium. Eventually, the rate of dissolution reaches a predetermined cutoff level, and the leaching process is terminated.

The uranium content of the solution collected from the bottom of the heap is usually maintained at a fairly constant level. This is controlled by the makeup of the solution and the contact time. If proper conditions are maintained, 60 to 80 percent of the uranium in the ore will be recovered, depending upon the percentage of material actually saturated by the leach solution. The usual desired rate of recovery is 1.0 to 2.0 grams of U_3O_8 per liter of solution. Uranium bearing solution is sent to a final recovery facility. If the uranium content drops below 1.0 grams per liter, the solution is usually recirculated.

The use of an acid leach solution has been emphasized in this article because most experience with heap leaching of uranium has involved sandstone ores in the western US. The leached ores generally contain the secondary uranium minerals carnotite and antunite, both of which are readily dissolved by acid in the absence of an oxidant. However, an oxidant may be required to keep the dissolved uranium in solution throughout the leach cycle. In that case, a chlorate is added to the leach solution at the make-up point.

Primary uranium minerals, mainly uraninite or pitchblende, can also be recovered by heap leaching. They require an oxidizing agent such as hydrogen peroxide, chlorate or oxygen to bring about dissolution. An acid solution is faster acting than the oxidants, however it is also non-discriminating and most minerals contained in the ore-bearing material are affected by the acid. This causes higher acid consumption and extra clean-up steps in the final stages of processing. Both effects add to project costs.

Conclusion

Historically, the use of heap leaching has been dependent on favorable economics and the mineralogical characteristics of the material to be leached. As is currently the case for all aspects of uranium mining and processing, operational and economic advantages once available by heap leaching have been gjeopardized by recently enacted environmental regulations. Nevertheless, when considered as an alternative to conventional recovery methods, heap leaching can still be a viable method for the recovery of uranium from low grade ores.

STATISTICAL DATA

EXCHANGE VALUE—$28.50/lb U_3O_8
Determined as of September 30, 1980

Definition

The Exchange Value is Nuexco's judgment of the price at which transactions for significant quantities of natural uranium concentrates could be concluded as of the last day of the month.

Derivation

Nuexco bases the Exchange Value upon:

A. Data from recently completed transactions.
B. Data from pending transactions.
C. Firm bids to buy and firm offers to sell.
D. Prices purchasers have expressed a willingness to pay, but for which Nuexco is not aware of firm bids to buy, and prices sellers have expressed a willingness to accept, but for which Nuexco is not aware of firm offers to sell.

Comments

Nuexco does not consider the following in determining the Exchange Value:

A. The price of uranium delivered or to be delivered under old contracts.
B. The price of uranium delivered in connection with contract renegotiations or other than arm's length transactions.

TRANSACTION VALUE
Determined as of September 30, 1980

$/lb U_3O_8	Millions of Pounds	Number of Transactions	Number of Months
30.60	2.0	15	4

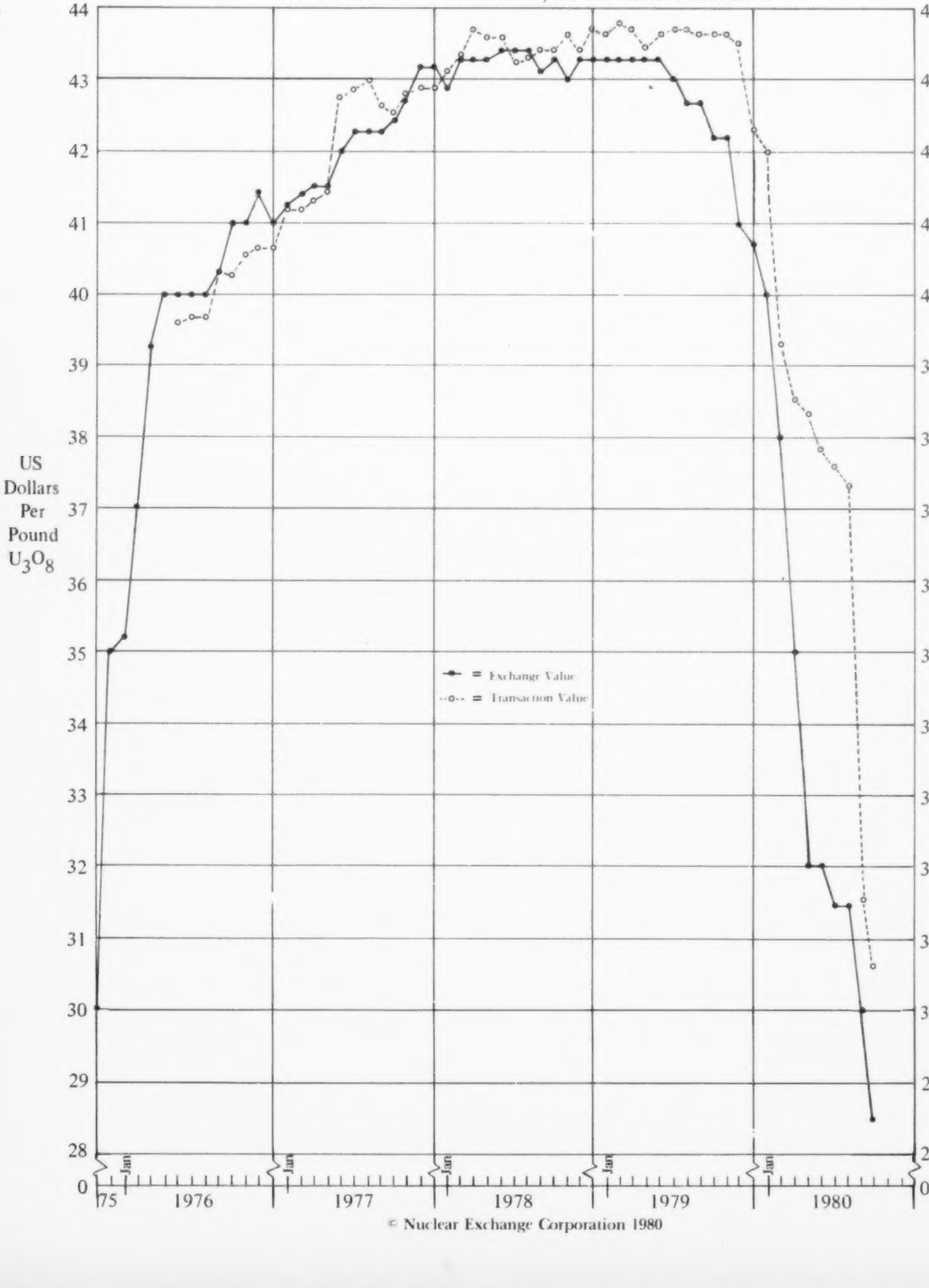
Definition

The Transaction Value is a weighted average price of recent transactions, and is based on prices paid for U_3O_8 in transactions closed within the previous three-month period and for which delivery was scheduled within one year of the transaction date. At least ten transactions totaling at least two million pounds U_3O_8 are included in each calculation, or the sample time is extended as necessary to include these minima. Foreign currencies are converted to US dollars as of the transaction date.

STATISTICAL DATA

EXCHANGE AND TRANSACTION VALUES SINCE NOVEMBER 1975

Determined as of the last day of the month indicated



STATISTICAL DATA

HISTORICAL EXCHANGE VALUES

Determined as of the last day of the month indicated
(US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1968	–	–	–	–	–	–	–	6.35	6.35	6.40	6.45	6.50
1969	–	6.35	6.10	6.10	6.25	6.25	6.20	6.20	6.15	6.15	6.15	6.20
1970	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.20	6.15	6.15	6.15	6.15
1971	6.20	6.20	6.20	6.20	6.15	6.05	6.00	5.95	5.95	5.95	5.95	5.95
1972	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95
1973	5.95	6.00	6.10	6.20	6.45	6.50	6.50	6.50	6.50	6.50	6.75	7.00
1974	7.70	7.90	8.00	9.00	9.50	10.50	11.50	12.00	12.50	14.00	14.75	15.00
1975	16.00	16.00	18.00	20.00	21.00	23.00	24.70	26.00	26.00	28.50	30.00	35.00
1976	35.20	37.00	39.25	40.00	40.00	40.00	40.00	40.40	41.00	41.00	41.50	41.00
1977	41.35	41.50	41.60	41.60	42.00	42.25	42.25	42.25	42.40	42.75	43.20	43.20
1978	42.90	43.25	43.25	43.25	43.40	43.40	43.40	43.10	43.25	43.00	43.25	43.25
1979	43.25	43.25	43.25	43.25	43.25	43.00	42.70	42.70	42.20	42.20	41.00	40.75
1980	40.00	38.00	35.00	32.00	32.00	31.50	31.50	30.00	28.50			

Note: See earlier Nuexco Reports for evolution of the definition of Exchange Value.

HISTORICAL TRANSACTION VALUES

Determined as of the last day of the month indicated
(US Dollars/lb. U_3O_8)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1976	–	–	–	–	39.60	39.70	39.70	40.40	40.30	40.60	40.70	40.70
1977	41.30	41.30	41.40	41.50	42.80	42.90	43.00	42.60	42.50	42.80	42.90	42.90
1978	43.10	43.30	43.70	43.60	43.60	43.20	43.30	43.40	43.40	43.60	43.40	43.70
1979	43.60	43.80	43.70	43.40	43.60	43.70	43.70	43.60	43.60	43.60	43.50	42.30
1980	42.00	39.30	38.60	38.40	37.90	37.60	37.30	31.60	30.60			

Note: See Nuexco Report 135 for a discussion of the definition of Transaction Value.

STATISTICAL DATA

EXCHANGE VALUE EXPRESSED IN SELECTED PRODUCER & CONSUMER CURRENCIES*

Country	per lb U_3O_8 in Concentrates	per kg U_3O_8 in Concentrates	per kg U in Concentrates
US (dollar)	28.50	62.83	74.09
France (franc)	119.00	262.35	309.37
FRG (mark)	51.30	113.09	133.36
Japan (yen)	6,128	13,509	15,931
Switzerland (franc)	46.93	103.46	122.00
UK (pound)	11.87	26.16	30.85
Australia (dollar)	24.35	53.69	63.32
Canada (dollar)	33.19	73.16	86.28
Niger, Gabon (CFA)	5,950	13,117	15,468
South Africa (rand)	21.44	47.28	55.75

*Calculated using currency exchange rates published in the Wall Street Journal on the last Friday of the month.

LOAN USE CHARGE RATE—7.0%/year

Definition

The Loan Use Charge Rate is Nuexco's judgment of the annual interest rate at which uranium loans could be concluded as of the last day of the month.

Derivation

Nuexco bases the Loan Use Charge Rate upon:

A. Data from recently completed or pending loan transactions.
B. Rates included in firm proposals to borrow or lend.
C. Rates that potential borrowers and lenders have expressed a willingness to pay or accept, but for which Nuexco is not aware of firm proposals.

STATISTICAL DATA

CURRENT TRANSACTIONS*

Nuexco Reference Number	Delivery Period	Approximate Quantity (thousands of pounds, U_3O_8 equivalent)	Approximate Price as percent of Current E.V.	Seller Group	Buyer Group	Remarks
1206	80	101 – 300	98	US	Europe	
1209	81-85	601 – 1000	–	US	US	Price related to market.
1210	80	51 – 100	98	US	Europe	

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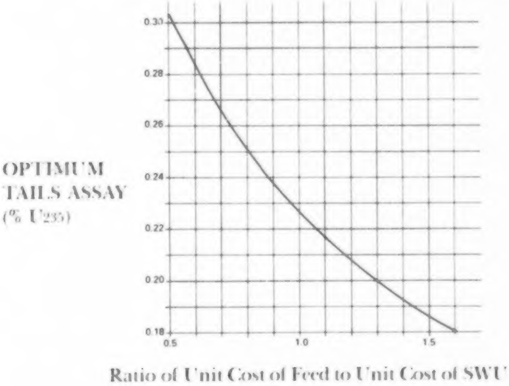
*Transactions listed include not only those in which Nuexco was involved, but also all others of which Nuexco is aware.

STATISTICAL DATA

OPTIMUM TAILS ASSAY

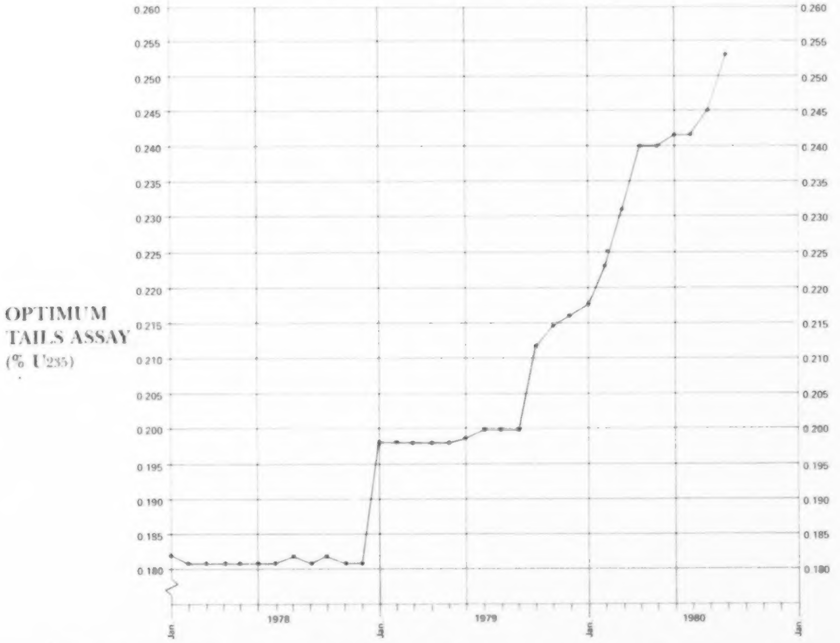
The optimum tails assay is the tails composition at which the cost of enriched uranium is lowest for given costs of separative work (SWU) and natural uranium feed. It depends only on the ratio of the cost of a kilogram of natural uranium in the form of UF_6 to the cost of a kilogram unit of separative work. The US Department of Energy (USDOE) Adjustable Fixed Commitment (AFC) enrichment contract holders have the option, within limits, to specify the transaction tails assay. The transaction tails assay for USDOE Requirements contracts is 0.2 percent U_{235}. For every one-hundredth of one percent increase in the transaction tails assay, uranium consumption increases about two percent.

TAILS ASSAY FOR MINIMUM COST OF PRODUCT*



*From Nuexco Report 138

HISTORICAL OPTIMUM TAILS ASSAY[1]



[1] Based on Exchange Value and USDOE AFC SWU price; interpolated to the nearest thousandth.

STATISTICAL DATA

US GOVERNMENT STATISTICS

	Producer Price Index—Industrial Commodities (1967 = 100)[1]	Consumer Price Index (1967 = 100)[2]	GNP Implicit Price Deflator (1972 = 100)[3]	Gross Average Hourly Earnings of Production or Non-supervisory Workers (US$)[4]		
				Metal Mining (SIC 10)	Primary Non-ferrous Metals (SIC 333)	Chemicals and Allied Products (SIC 28)
Annual Avg. 1970 (5)	110.0	116.3	91.36	3.88	3.87	3.69
Annual Avg. 1971 (5)	114.1	121.3	96.02	4.12	4.15	3.97
Annual Avg. 1972 (5)	117.9	125.3	100.00	4.56	4.59	4.26
Annual Avg. 1973 (5)	125.9	133.1	105.80	4.84	4.98	4.51
Annual Avg. 1974 (5)	153.8	147.7	116.02	5.44	5.63	4.88
Annual Avg. 1975 (5)	171.5	161.2	127.15	6.13	6.24	5.39
Annual Avg. 1976 (5)	182.4	170.5	133.71	6.76	6.87	5.91
Annual Avg. 1977 (5)	195.1	181.5	141.70	7.28	7.67	6.43
Annual Avg. 1978 (5)	209.4	195.4	152.05	8.23	8.56	7.01
Annual Avg. 1979	236.5	217.4	165.46	9.27	9.50	7.59
Jun 1979	234.0	216.6	163.81	9.09	9.44	7.53
Jul 1979	237.5	218.9	–	9.32	9.57	7.60
Aug 1979	240.6	221.1	–	9.38	9.70	7.65
Sep 1979	244.2	223.4	167.20	9.63	9.79	7.73
Oct 1979	249.0	225.4	–	9.67	9.87	7.82
Nov 1979	250.6	227.5	–	9.79	9.86	7.87
Dec 1979	253.1	229.9	170.58	9.80	9.92	7.91
Jan 1980	260.6	233.2	–	9.92	10.06	7.96
Feb 1980	265.9	236.4	–	9.93	10.01	7.99
Mar 1980	268.2	239.8	174.48	9.91	10.23	8.04
Apr 1980	270.7	242.5	–	10.00	10.30	8.12
May 1980	271.2	239.8	–	10.18	10.37	8.17
Jun 1980	273.0	247.6	178.93	10.13	10.69	8.24
Jul 1980	275.6P	247.8	–	10.18P	10.80P	8.35P
Aug 1980	277.3P	249.4	–	–	–	8.39P

P = Preliminary   R = Revised since last month

(1) US Bureau of Labor Statistics, Washington, D.C.; "Producer Prices and Price Indexes," Table 6 (formerly "Wholesale Prices and Price Indexes"). Producer Price Indexes are revised four months after they are first released to reflect the availability of late reports and corrections by respondents.

(2) US Bureau of Labor Statistics, Washington, D.C.; Consumer Price Index for All Urban Consumers, US City Average, All Items.

(3) US Department of Commerce, Washington, D.C.; Bureau of Economic Analysis, National Income and Wealth Division; "Survey of Current Business," Table A. The GNP Implicit Price Deflator is published quarterly, and seasonally adjusted.

(4) US Bureau of Labor Statistics, Washington, DC.; "Employment and Earnings," Table C-2. All data based on 1972 revision of SIC Manual. Data for 1970-1976 are adjusted to the March 1977 benchmark. Data for January 1977 through March 1980 are adjusted to the March 1978 benchmark. Data for April 1980 and beyond are adjusted to the most recent benchmark—March 1979.

(5) Data for 1970-1978, monthly except for the GNP Implicit Price Deflator, appear on pages 4.6 through 4.8 of Nuexco Report 139.

STATISTICAL DATA

AUSTRALIAN GOVERNMENT STATISTICS

	Price Index of Materials Used in Manufacturing Industry—All Groups (Year 1968-69 = 100.0)[1]	Weighted Average Minimum Weekly Wage Rates—Adult Males Australia Mining and Quarrying (A$)[2]
Annual Avg. 1970 (3)	101.4	59.88
Annual Avg. 1971 (3)	101.5	65.95
Annual Avg. 1972 (3)	105.6	71.26
Annual Avg. 1973 (3)	124.4	78.96
Annual Avg. 1974 (3)	141.9	108.07
Annual Avg. 1975 (3)	150.4	132.55
Annual Avg. 1976 (3)	168.4	160.93
Annual Avg. 1977 (3)	192.0	179.03
Annual Avg. 1978 (3)	215.4	190.04
Annual Avg. 1979	248.5	196.34
Apr 1979	274.0	192.46
May 1979	288.5	193.55R
Jun 1979	294.9	196.63R
Jul 1979	298.2	199.20R
Aug 1979	293.2	200.27R
Sep 1979	302.4	201.05R
Oct 1979	309.4	200.51R
Nov 1979	310.4	199.85R
Dec 1979	319.4	200.66R
Jan 1980	340.1	215.43R
Feb 1980	345.6	214.89R
Mar 1980	340.3	214.35R
Apr 1980	327.9	214.65R
May 1980	335.1P	214.24R
Jun 1980	338.4P	213.58P
Jul 1980	–	–

P = Preliminary   R = Revised since last month

(1) Australian Bureau of Statistics, Canberra; "Price Index of Materials Used in Manufacturing Industry" (Catalogue No. 6411.0), Table 3.

(2) Australian Bureau of Statistics, Canberra; "Wage Rates, Australia" (Catalogue No. 6312.0), Table 1. Figures for the latest fourteen months shown are subject to revision.

(3) Monthly data for 1970 through 1978 appear on pages 4.7 and 4.8 of Nuexco Report 138.

STATISTICAL DATA

CANADIAN GOVERNMENT STATISTICS

	Industry Selling Price Index: Manufacturing (D 500000)[1,2] (1971 = 100.0)	Wage-earner Data: Average Hourly Earnings (C$)[3,4]		
		Metal Mining, including milling (SIC 050-059)	Primary Metal Industries, non-ferrous (SIC 296-298)	Chemicals and Chemical Products (SIC 370-379)
Annual Avg. 1977	174.3	8.18	6.50	6.51
Annual Avg. 1978	190.4	8.76	6.82	6.97
Annual Avg. 1979	217.9	9.60	7.35	7.67
May 1979	214.5	9.65	7.28	7.61
Jun 1979	216.0	9.49	7.27	7.66
Jul 1979	218.3	9.37	7.34	7.73
Aug 1979	220.0	9.56	7.38	7.77
Sep 1979	223.4	9.75	7.50	7.81
Oct 1979	227.4	9.89	7.54	7.88
Nov 1979	228.1	9.97	7.61	7.91
Dec 1979	230.4	9.93	7.51	7.89
Jan 1980	239.0R	9.96	7.57	7.99
Feb 1980	240.8R	10.11	7.69	8.08
Mar 1980	239.5R	10.34	7.83	8.26
Apr 1980	241.1R	10.40P	7.94P	8.36P
May 1980	242.2R	10.49P	8.02P	8.44P
Jun 1980	243.3	—	—	—
Jul 1980	245.8P	—	—	—

P = Preliminary R = Revised since last month

(1) Statistics Canada, Prices Division, Ottawa; "Industry Price Indexes" (Catalogue 62-011), Table 1. Indexes for the most recent six months shown are subject to revision.

(2) Monthly data for 1973 through 1978 appear on page 4.10 of Nuexco Report 138.

(3) Statistics Canada, Labour Division, Employment and Payrolls Section, Ottawa; "Employment, Earnings and Hours" (Catalogue 72-002), Table 2.

(4) Monthly data for 1977 and 1978 appear on page 4.11 of Nuexco Report 138.

REPUBLIC OF SOUTH AFRICA STATISTICS

	Average Declared Working Costs per Metric Ton of Gold Ore Milled (Rand)[1]	Consumer Price Index[2] (1975 = 100, except where otherwise indicated)
Annual Avg. 1970 (3)	7.34	100.3 (4)
Annual Avg. 1971 (3)	7.88	106.4 (4)
Annual Avg. 1972 (3)	8.79	113.3 (4)
Annual Avg. 1973 (3)	10.51	124.1 (4)
Annual Avg. 1974 (3)	13.18	138.5 (4)
Annual Avg. 1975 (3)	16.71	157.2 (4)
Annual Avg. 1976 (3)	19.30	174.7 (4)
Annual Avg. 1977 (3)	23.87	194.4 (4)
Annual Avg. 1978 (3)	27.14	137.2
Annual Avg. 1979 (3)	30.18	155.3
Jun 1979	29.44	152.4
Jul 1979	–	157.9
Aug 1979	–	160.2
Sep 1979	30.71	162.1
Oct 1979	–	162.9
Nov 1979	–	163.4
Dec 1979	31.89	164.0
Jan 1980	–	165.4
Feb 1980	–	167.0
Mar 1980	33.65	168.0
Apr 1980	–	170.0
May 1980	–	171.9
Jun 1980	34.08	174.6
Jul 1980	–	–
Aug 1980	–	–

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(1) Chamber of Mines of South Africa, Johannesburg: "Analysis of Working Results," published quarterly.
(2) Republic of South Africa Department of Statistics, Pretoria: "Government Gazette: Consumer Price Index for Urban Areas."
(3) Historical data for 1970 through 1979 appear on page 4.9 of Nuexco Report 140.
(4) April 1970 = 100.00

MARKET OPPORTUNITIES

Market Opportunities are *active* inquiries in the uranium market to buy, sell, borrow or lend. The data presented in this section are in no way intended to be indicative of the entire uranium market for the time period covered.

URANIUM SUPPLY

Nuexco Reference Number	Delivery Period* (Thousands of Pounds U_3O_8)			Remarks
	0 to 1 Year	1 to 2 Years	2 to 3 Years	
Available for Sale:				
1236			150	Long term
1284	250			
1286	150	150	150	Long term
1392	300			
1394	250			
1417	1000			UF_6
1475	1000			UF_6
1479	525			
1481	250			
1496	500			
1502	500			UF_6
1506		200	200	Long term
TOTALS	4725	350	500	
Available for Loan:				
1175	700			UF_6
1234	700			
1354	600			UF_6
1355	600			
1429	500			
1492	700			UF_6
TOTAL	3800			

***Measured from the date of this Report.**

MARKET OPPORTUNITIES

Market Opportunities are *active* inquiries in the uranium market to buy, sell, borrow or lend. The data presented in this section are in no way intended to be indicative of the entire uranium market for the time period covered.

URANIUM DEMAND

Nuexco Reference Number	Delivery Period* (Thousands of Pounds U_3O_8)			Remarks
	0 to 1 Year	1 to 2 Years	2 to 3 Years	
Inquiries to Purchase:				
1321	900			
1408	150			
1459		200	200	Long term
1462			100	Long term
1470	25			
1488	120			
1489	200			
1497	500			
1501	150			
TOTALS	2045	200	300	
Inquiries to Borrow:				
1220	500			
1504	1000			UF_6
TOTAL	1500			

***Measured from the date of this Report.**

MARKET OPPORTUNITIES

Market Opportunities are *active* inquiries in the secondary market for UF_6 conversion services. The data presented in this section are in no way intended to be indicative of the entire market for the time period covered.

CONVERSION SUPPLY

Nuexco Reference Number	Thousands of Pounds U as UF_6				Remarks
	1980	1981	1982	1983	
P-1282	250	250			
P-1424	1000				
P-1450	1000				
P-1451	175				
TOTALS	2425	250			

CONVERSION DEMAND

Nuexco Reference Number	Thousands of Pounds U as UF_6				Remarks
	1980	1981	1982	1983	
P-1505	770				

INDEX

Uranium Market Index	134	135	136	137	138	139	140	141	142	143	144	145
Projected US & Free World Production	1.2		1.0			1.0		1.2				
Forecast of US Production												5-8
Actual US & Free World Production		1.3			1.5			1.5			5	
US Import-Export Balance		1.5							6	4		
Apparent Future Consumption							1.1				2, 4	
USDOE Forecast of Uranium Requirements											7	
Natural Uranium Supply & Demand Balance		1.0	1.0						1-8			1-5
Projection of Installed Nuclear Capacity							1.2	1.7			3	
Past Nuclear Electric Power Generation						1.1						
Sales Summary						1.2						

Report Number	Topical Essay/Commentary	Page Number	Raw Materials	Page Number
134	Marketing & Procurement: Tools of the Trade I	2.0	Northern Colorado Plateau	3.0
135	Marketing & Procurement: Tools of the Trade II	2.0	Northeastern Washington	3.0
136	Spot and Other Markets	2.0	By-Product Uranium from Phosphate I	3.0
137	Uranium Prices and Price Mechanisms	2.0	By-Product Uranium from Phosphate II	3.0
138	Forward Cost	2.0	By-Product Uranium from Phosphate III	3.0
139	Market Pricing	2.0	South Australia	3.0
140	Marketing & Procurement: Delivery & Payment	2.0	Quartz-Pebble Conglomerates I	3.0
141	National Decision Making	2.0	Quartz-Pebble Conglomerates II	3.0
142	Some Perspectives on Uranium Inventory	13	East Rand Gold & Uranium Company (ERGO)	16
143	Marketing & Procurement: UF_6 Conversion	8	Tallahassee Creek	14
144	Produce or Procure: Uranium Version of Make vs. Buy	10	Niger	15
	Contingency Planning for an Energy Emergency	13		
145	Historical Perspective on US Uranium Production	13	Argentina	17

NUEXCO
NUCLEAR EXCHANGE CORPORATION

3000 SAND HILL ROAD
MENLO PARK, CALIFORNIA 94025

EXECUTIVE SUMMARY & INDUSTRY OVERVIEW
NUEXCO REPORT 146

The **Exchange Value** declined this month to $28.50 per pound U_3O_8 from $30.00 last month. Sellers continued to aggressively compete for new business. Active spot and near term sellers include producers and both utility and non-utility inventory holders. Active spot and near term purchasers are mainly non-US utilities and US producers, although at least one US utility has recently decided to enter the near term market to take advantage of today's prices. Spot and near term inquiries to sell total about 4.7 million pounds U_3O_8, while inquiries to purchase in the same time frame amount to about two million pounds. Thus the market is becoming somewhat more balanced than it has been recently.

Three transactions closed this month, all involving US producers as sellers. The buyers in two of the transactions were European utilities. The third buyer was a US utility. The **Transaction Value** declined to $30.60 per pound U_3O_8 from $31.60 last month.

The US Department of Energy (USDOE) "Survey of United States Uranium Marketing Activity" was issued this month. Data on US production and prices contained in the USDOE survey are discussed in this month's Nuexco Report.

An amendment aimed at restricting use of non-US uranium in US reactors was removed from the 1981 appropriations bill for USDOE by a House-Senate conference committee. This action is addressed in the *Commentary* section of this Report, along with some general comments on the uranium embargo question.

Some additional details of the financial structure and sales commitments of Energy Resources of Australia (ERA) have become available and are outlined in this Report.

This month's *Topical Essay* compares the depressed uranium market of the early 1970's with today's market, and assesses whether a market recovery similiar to that of the mid-1970's is likely.

The *Raw Materials* section discusses the process of recovering uranium by heap leaching.

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10/80

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Erratum

Table 11 of last month's Report (Number 145, September, 1980) was garbled in typesetting. A corrected version is printed on the reverse side of this page.

Table 11
DATA USED TO DEVELOP FIGURES 3 AND 4 OF THIS REPORT

Year	USAEC Annual Average Price Paid[1] [2]	NUEXCO Average Annual Exchange Value	USDOE Annual Average Price Paid[3] by US Utilities	GNP Implicit Price Deflator[4] (1972 = 100)	Annual Average US Grade of Ore[1] (percent U_3O_8)
1950	9.11			53.64	0.32
1951	10.10			57.27	0.32
1952	11.18			58.00	0.30
1953	12.35			58.88	0.31
1954	12.27			59.69	0.32
1955	12.25			60.98	0.29
1956	11.51			62.90	0.28
1957	10.49			65.02	0.27
1958	9.45			66.06	0.27
1959	9.12			67.52	0.25
1960	8.75			68.67	0.24
1961	8.50			69.28	0.23
1962	8.15			70.55	0.24
1963	7.82			71.59	0.25
1964	8.00			72.71	0.26
1965	8.00			74.32	0.24
1966	8.00			76.76	0.23
1967	8.00			79.02	0.20
1968	8.00	6.40		82.57	0.20
1969	6.99	6.20		86.72	0.21
1970	5.74	6.25		91.36	0.20
1971	5.54	6.06		96.02	0.21
1972		5.95		100.00	0.21
1973		6.40		105.80	0.21
1974		11.00		116.02	0.18
1975		23.70	10.50	127.18	0.16
1976		39.70	16.10	133.88	0.15
1977		42.20	19.75	141.61	0.15
1978		43.25	21.60	152.05	0.13
1979		42.60	23.85	165.46	0.11
1980		33.75[5]		174.51[6]	

[1] Statistical Data of the Uranium Industry; January 1, 1980; GJO-100(80).

[2] Data is for fiscal year indicated.

[3] Survey of United States Uranium Marketing Activity; August 1979; DOE/RA-0038.

[4] US Department of Commerce, Washington, D.C.; Bureau of Economic Analysis "Survey of Current Business."

[5] First eight months.

[6] First quarter.

NUEXCO
NUCLEAR EXCHANGE CORPORATION

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